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NEMA BI-50016-2024
(formerly NEMA VE 2-2018)
Cable Tray Installation Guidelines

Endorsed by Cable Tray Institute
www.cabletrays.com

Published by:
National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209
www.nema.org

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264

Foreword

267 **For cable tray installers:** NEMA BI-50016-2024 (hereinafter referred to as NEMA BI-50016) is intended
268 as a practical guide for the proper installation of cable tray systems. Cable tray system design shall
269 comply with *National Electrical Code® (NEC®)* Article 392, NEMA BI-50015 (formerly VE 1), and NEMA
270 FG 1, and follow safe work practices as described in NFPA 70E.

271 NEMA BI-50016 guidelines and information do not intend to cover all details or variations in cable tray
272 systems nor provide for every possible installation contingency.

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

276 NEMA BI-50016 guidelines are useful to engineers, contractors, and maintenance personnel. In the
277 future, NEMA BI-50016 will be updated periodically to reflect evolving technology and construction
278 techniques.

279 Comments and suggestions for the improvement of this document are encouraged. They should be sent
280 to:

281 NEMA Technical and Industry Affairs Department
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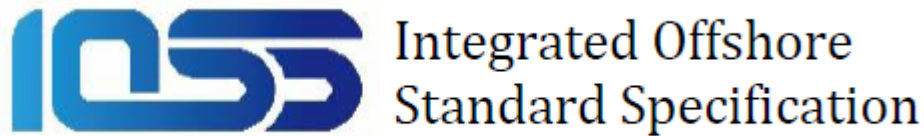
285 This is the fourth edition of NEMA BI-50016. This document was formerly designated NEMA VE 2-2018.

286 NEMA BI-50016 was developed by the NEMA Cable Tray Section in conjunction with the members of the
287 Integrated Offshore Standard Specification and Unified Bulk. Section approval does not necessarily imply
288 that all section members voted for approval or participated in development. At the time NEMA BI-50016
289 was approved, the NEMA Cable Tray Section consisted of the following members:

- 290 – ABB Inc. <https://new.abb.com/low-voltage/products/wire-cable-management/cable-tray>
- 291 – Cope, A part of Atkore International www.copecabletray.com/
- 292 – Chalfant Manufacturing Co. www.chalfantcabletray.com/
- 293 – Eaton's B-Line Business www.cooperindustries.com/content/public/en/b-line.html
- 294 – Legrand/Cablofil, Inc. www.legrand.us/cablofil
- 295 – MP Husky Corp. www.mphusky.com/
- 296 – Oglaend System US LLC www.oglaend-system.com/newsread/index.aspx
- 297 – Snake Tray, Inc. www.snaketray.com/
- 298 – Techline Manufacturing www.techlinemfg.com

Members of the Integrated Offshore Standard Specification and Unified Bulk were active in harmonizing this standard and in providing suggestions and comments in the revision of this standard.

- Unified Bulk Joint Industry Project (UBJIP) <https://www.iooss.info/>
- Integrated offshore standard specification (IOSS) <https://www.iooss.info/>
- American Bureau of Shipping (ABS) Korea <https://ww2.eagle.org/en.html> (E&I Leader)
- Det Norske Veritas (DNV), Korea <https://www.dnv.com/>
- Bureau Veritas (BV), Korea <https://marine-offshore.bureauveritas.com/bv-fleet/#/bv-fleet/>
- Daewoo Shipbuilding & Marine Engineering (DSME) <https://www.dsme.co.kr/epub/main/index.do>
- Hyundai Heavy Industries (HHI) <https://english.hhi.co.kr/>
- Korea Marine Equipment Research Institute (KOMERI) <http://eng.komeri.re.kr/smartcms/page/main>
- Korea Offshore & Shipbuilding Association (KOSHIPA) <https://www.koshipa.or.kr/>
- Lloyd's Register (LR) <https://www.lr.org/en/>
- Samsung Heavy Industries (SHI) <http://www.samsungshi.com/eng/>
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1 Scope

1.1 Scope

NEMA BI-50016 (formerly VE 2) addresses shipping, handling, storing, and installing cable tray systems, and provides information on maintenance and system modification.

1.2 General

WARNING—Do not use a cable tray as a walkway, ladder, or support for people; a cable tray is a mechanical support system for cables and raceways. Using cable trays as walkways can cause personal injury and can damage cable trays and installed cables.

Hazardous voltages in electrical equipment can cause severe personal injury or death. Safety-related work practices, such as those described in NFPA 70E or CSA Z462, as well as all applicable OSHA regulations, should be followed at all times.

Performance of a cable tray wiring system depends on 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, that person is:

- a. trained and authorized to test, energize, clear, ground, tag, and lock-out circuits, in accordance with established safety practices; and
- b. trained in the proper care and use of protective equipment, such as insulated rubber gloves, hard hats, safety glasses or face shields, dust masks, and flash-resistant clothing, in accordance with established safety practices.

1.3 Definitions, Abbreviations, and Acronyms

The following definitions, abbreviations, and acronyms appear in NEMA BI-50016 (formerly VE 2) or NEMA BI-50015 (formerly VE 1).

accessory: A component used to supplement the function of a straight section or fitting. Examples include, but are not limited to, dropout, cover, conduit adapter, hold-down device, and divider.

cable tray support span: The distance between the centerlines of supports.

cable tray system: A section or assembly of sections, and associated fittings, forming a mechanical system used to support cables and raceways.

channel cable tray: A fabricated structure consisting of a one-piece ventilated- or solid-bottom channel section.

classified: Indicates that a product has been evaluated to meet a specific purpose, e.g., classified as to its suitability for use as an equipment grounding conductor.

connector: A component that joins any combination of cable tray straight sections and fittings.

Note: The basic types of connectors include rigid, expansion, adjustable, and reducer. The term “splice” is also used in the industry to describe a connector.

degrees Celsius (°C)

degrees Fahrenheit (°F)

electromagnetic interference (EMI)

electrostatic discharge (ESD)

equipment grounding conductor (EGC)

fasteners: Screws, nuts, bolts, washers, rivets, spacers, pins, and other items used to connect and assemble cable tray systems.

fill depth: The vertical interior dimension of a cable tray that is used to calculate the allowable interior cross-sectional area.

fitting: A component that is used to change the size or direction of a cable tray system.

hot dipped galvanized after fabrication (H.D.G.A.F.)

horizontal cross: A fitting that joins cable trays in four directions at 90° intervals in the same plane.

horizontal elbow: A fitting that changes the direction of a cable tray in the same plane.

horizontal tee: A fitting that joins cable trays in three directions at 90° intervals in the same plane.

389 **horizontal wye:** A fitting that joins cable trays in three directions at other-than-90° intervals in the same plane.

390 **ladder cable tray:** A fabricated structure consisting of two longitudinal side rails connected by individual
391 transverse members (rungs).

392 **less than truckload (LTL)**

393 **radio frequency interference (RFI)**

394 **reducer:** A fitting that joins cable trays of different widths in the same plane.

395 **left-hand reducer:** A reducer having, when viewed from the large end, a straight side on the left.

396 **right-hand reducer:** A reducer having, when viewed from the large end, a straight side on the right.

397 **straight reducer:** A reducer having two symmetrical offset sides.

398 **side rail:** An integral or separate longitudinal structure of the cable tray that provides containment and a
399 degree of protection for the cables.

400 **single-rail cable tray:** A fabricated structure consisting of a longitudinal rail with transversely connected
401 members (rungs) that project from one side (side-supported) or both sides (center-supported), and that
402 may be single- or multi-tier.

403 **solid-bottom or non-ventilated cable tray:** A fabricated structure consisting of a bottom without
404 ventilation openings within integral or separate longitudinal side rails.

405 **straight section:** A length of cable tray that has no change in direction or size.

406 **support:** A component that provides a means for supporting a cable tray, including, but not limited to,
407 cantilever bracket, trapeze, and individual rod suspension.

408 **trough or ventilated cable tray:** A fabricated structure consisting of integral or separate longitudinal rails
409 and a bottom having openings sufficient for the passage of air and utilizing 75% or less of the plan area of
410 the surface to support cables where the maximum open spacings between cable support surfaces of
411 transverse elements do not exceed 100 mm (4 in.) in the direction parallel to the tray side rails.

412 Notes:

- 413 c. On horizontal bends only, the maximum distance between transverse elements is measured at the
414 centerline of the bend.
415 d. A ladder cable tray having rung spacing such that the cable tray meets the definition described above is
416 considered to be a ventilated cable tray.

417 **vertical elbow:** A fitting that changes the direction of a cable tray to a different plane.

418 **inside vertical elbow:** A fitting that changes the direction of a cable tray upward from the horizontal
419 plane.

420 **outside vertical elbow:** A fitting that changes the direction of a cable tray downward from the horizontal
421 plane.

422 **vertical tee:** A fitting that joins cable trays in three directions at 90° intervals in different planes.

423 **wire mesh cable tray:** A manufactured wire mesh tray consisting of steel wires welded at all
424 intersections.

wire mesh cable tray fitting: A fitting for wire mesh cable tray systems that is fabricated from wire mesh cable tray straight sections. The fitting is field-constructed and attached to the adjacent sections using splice connectors in accordance with the manufacturer's instructions.

1.4 References

Where reference is made to other publications, such reference shall be considered to refer to the latest edition and all amendments published to that edition up to the time when this standard was approved.

American Bureau of Shipping

1701 City Plaza Drive

Spring, TX 77389

<https://ww2.eagle.org>

ABS MVR

American Bureau of Shipping Marine Vessel Rules

ASTM International

100 Barr Harbor Drive, PO Box C700

West Conshohocken, PA, 19428-2959

<http://www.astm.org/>

ASTM A123/A123M

Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A653/A653M

Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A780

Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM B633

Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

Bureau Veritas

8 Cours du Triangle

92800 Puteaux, France

<https://marine-offshore.bureauveritas.com/>

Rules for the Classification of Offshore Units, Part C

CSA Group

8 Cours du Triangle

92800 Puteaux, France

<https://www.csagroup.org/>

Canadian Electrical Code, Part 1: Safety Standard for Electrical Installations

DNV

Thormøhlensgt. 49A

5006 Bergen, Norway

[dnv.com](https://www.dnv.com)

DNVGL-OS-D201

Electrical Installations

National Electrical Manufacturers Association

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Rosslyn, VA 22209-3801

www.nema.org

FG 1

Fiberglass Cable Tray Systems

BI-50015 (formerly VE 1)/

CSA 22.2 No. 126.1

Metal Cable Tray Systems

National Fire Protection Association

1 Batterymarch Park

Quincy, MA 02169-7471

www.nfpa.org

NFPA 70

National Electrical Code (NEC),

NFPA 70E

Standard for Electrical Safety in the Workplace

Unified Bulk Standardization JIP

UBJIP IOSS E101

Electrical and Instrumentation Components and Installation

- E101-1 Part 1: *Cable Tray*
- E101-2 Part 2: *Cable Tray Segregation*
- E101-3 Part 3: *Cable Tray Support*
- E101-4 Part 4: *Cable Tray Cover*

1.5 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 shall be marked by the manufacturer per NEMA BI-50015 (VE 1). In addition, cable tray may have tag number/unique identification number associated with the product and its installation location.

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

Flatbed trailers are often used for full truckload shipments and when customers want side forklift unloading or sling unloading by crane (special care must be exercised using slings so that cable tray is not crushed as a result of improper sling location and lifting. See Figure 1-1 and Figure 1-2.

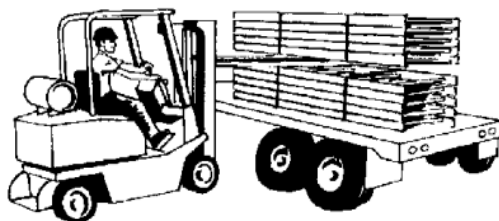


Figure 1-1—Correct



Figure 1-2—Incorrect (Except when Using Extended Forks for Skidded Bundles)

Small-to-medium-size orders less than 600 m (2,000 ft) are generally shipped via common carrier, LTL, in enclosed vans.

If unloading by hand, workers should wear gloves.

To prevent damage to cable tray, never pull cable tray from a truck trailer by chaining it to the bottom rung and dragging cable tray out of the trailer. See Figure 1-3 and Figure 1-4.

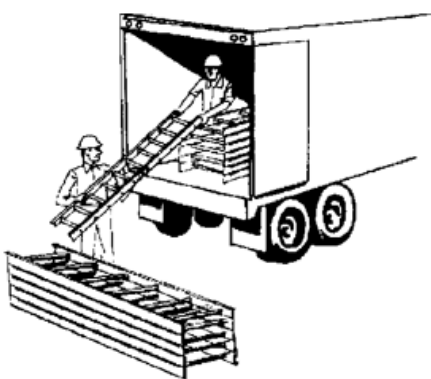


Figure 1-3—Correct

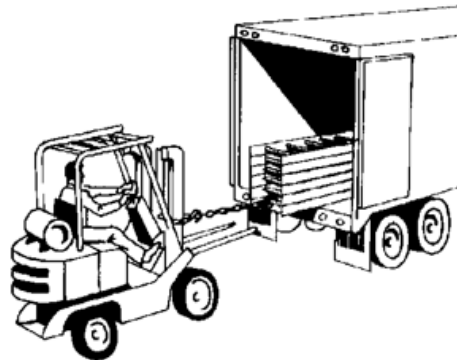


Figure 1-4—Incorrect

After unloading, inventory all items immediately using the manufacturer's packing list. Note on the bill of lading any shortage or shipping damage. That information will be necessary if filing a freight claim.

2 Storage

Hot-dipped galvanized after fabrication (H.D.G.A.F.) (see ASTM A123) steel, aluminum, and stainless steel cable tray and fiberglass or other nonmetallic 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 it.

Mill-galvanized (see ASTM A653) or electro-galvanized (see ASTM B633) cable tray must be protected or stored in a well-ventilated, dry location.

Bare steel cable tray should receive a protective coating as soon as possible to prevent surface rust.

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

3 Installation

For cable tray installers: NEMA 50016-2024 is intended as a practical guide for the proper installation of cable tray systems. Cable tray system design shall comply with NEC Article 392, NEMA VE 1, and NEMA FG 1, and shall follow safe work practices as described in NFPA 70E.

These instructions and information are not intended to cover all details or variations in cable tray systems; nor are they intended to 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.

3.1 Cable Tray Installation Locations

Where not allowed: NEC Article 392 states that cable tray systems shall not be installed in hoistways or where subject to severe physical damage. Metal cable tray systems may support conductor types allowed in certain areas, to include environmental air and classified locations. The restrictions apply to the conductors being installed, not the cable trays. Local codes apply.

Provide access: Cable tray systems are to be installed so that they are accessible

In possible fire areas: Cable tray installations should avoid possible fire areas. If that is not possible, and if there are critical circuits involved, stainless steel cable tray and fire-resistant cables should be considered. Wrapping cable tray in a flame-resistant blanket might create a cable-heating problem without a fire. Installing a physical fire shield beneath a cable tray system may provide only limited improvement and create other issues.

3.2 Common Tools for Installation

The following tools, including tools recommended by the manufacturers, are commonly used for installation of cable tray:

- a. metal cutting saw;
- b. touch-up material;
- c. screwdriver;
- d. drill with bits;
- e. file;
- f. open-end wrench;
- g. nylon cord or laser;
- h. sealant for cut edges (fiberglass);
- i. cutting saw (for fiberglass), carbide- or diamond-tipped;
- j. leveling device;
- k. tape measure;

- l. square;
- m. C-clamp;
- n. torque wrench;
- o. ratchet wrench;
- p. offset bolt cutters (wire mesh);
- q. dust mask (fiberglass);
- r. appropriate safety equipment.

3.3 Support Installation

Caution—Do not cut or drill or weld structural building members (e.g., I-beams) without approval by the general contractor.

To install the cable tray supports, find the required elevation from the floor to the bottom of the cable 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 locate the tops of the supports.

To speed the process of installing the trapeze hangers, some nuts may be pre-threaded onto the threaded rod to the approximate location where the nut will be needed. One method for pre-threading 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 while holding them with an open-end wrench.

Note: Non-metallic supports and hardware may require special load-bearing considerations because of material composition and application temperature. Consult the cable tray manufacturer for recommended practices.

Caution—Supports for cable trays should provide strength and working load capabilities sufficient to meet the load requirement of the cable tray wiring system. Consideration should be given to loads associated with future cable additions (see Section 5.3) or any other additional loads applied to the cable tray system or the cable tray support system.

Note 1: Supports shown in Figure 3-1 through Figure 3-9 are typical examples, however supports should be in accordance with manufacturers recommendations.

Note 2: Non-metallic supports and hardware may require special load-bearing considerations because of material composition and application temperature.

Note 3: Special consideration may be required for center-supported systems and cantilevered systems, considering eccentric loading.

Note 4: Installations requiring seismic considerations affect the cable tray system supports. The supports should be braced according to the relevant seismic zone. Contact the manufacturer for approved bracing information.

3.3.1 Trapeze Type

Trapeze-type supports consist of a horizontal support under the cable tray with minimum of two vertical attachments to the structure above (see 3.3, Note 1). For examples of trapeze-type supports, see Figure 3-1 through Figure 3-9.

To install:

- a. Thread nuts onto threaded rod approximately 50 mm (2 in) above the desired location for the bottom of the cable tray.

- b. Slide on square washers followed by the cross member and second set of square washers.
- c. Thread the second set of nuts onto the threaded rod.
- d. Move the cross member so that the top surface is located where the bottom of the cable tray run will be located.
- e. Move the second set of nuts up the threaded rod until the cross member is reached and held in place.
- f. Make sure the cross member is level, then move the first set of nuts down the threaded rod until the 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.

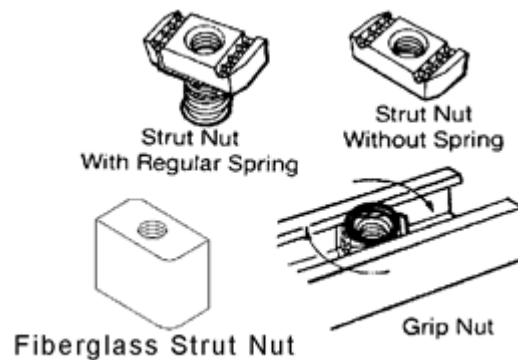


Figure 3-1—Typical Strut Nut

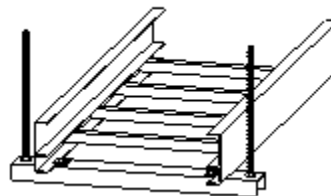


Figure 3-2—C-Channel Support

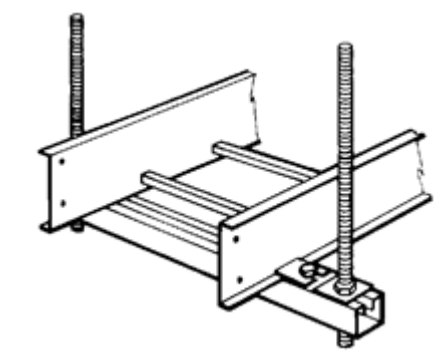


Figure 3-3—Strut Support

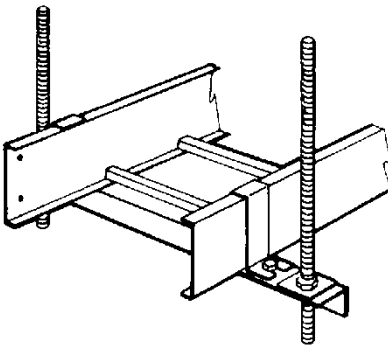


Figure 3-4—Angle Iron and Threaded Rod Support

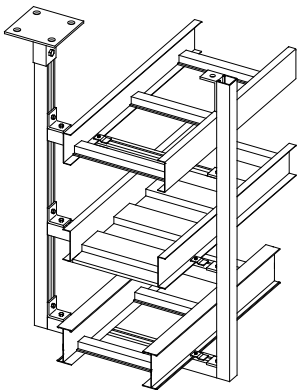


Figure 3-5—Typical Strut Support Installation

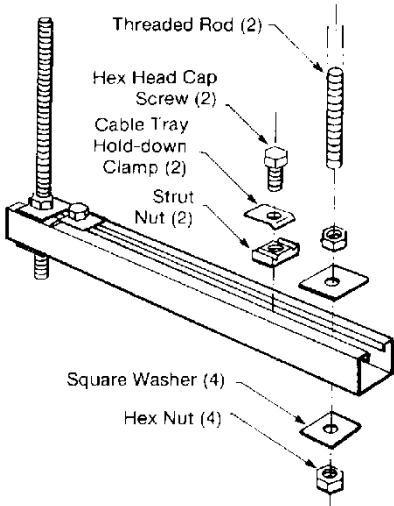


Figure 3-6—Typical Strut Support (Exploded View)

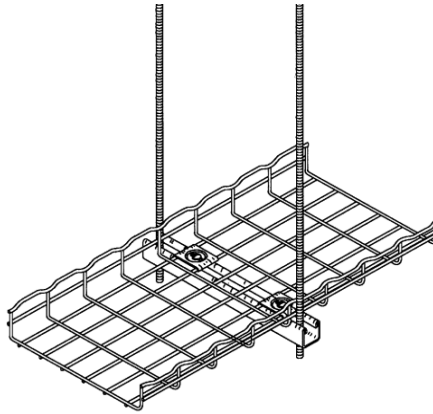


Figure 3-7—Wire Basket Strut Support

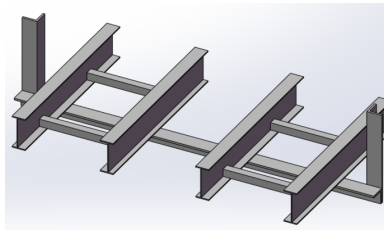


Figure 3-8—Multi-Tray Rigid Support

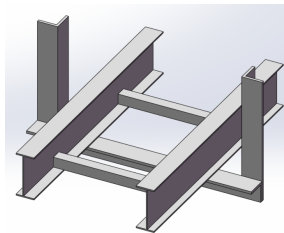


Figure 3-9—Rigid Support

3.3.2 Hanger Rod Clamp

For examples, see Figure 3-10 through Figure 3-14. To install:

- a. Thread nuts onto threaded rod approximately 225 mm (9 in.) above the desired location for the bottom of the cable tray.
- b. Place a clamp around the side rail of the cable tray.
- c. Lift the entire cable tray section onto the threaded rod, running the threaded rod through the holes in the clamps.
- d. Thread a second set of nuts onto the threaded rod, moving them up until the bottom of the cable tray reaches the desired location.
- e. Move the first set of nuts down the threaded rod and secure clamps in place.

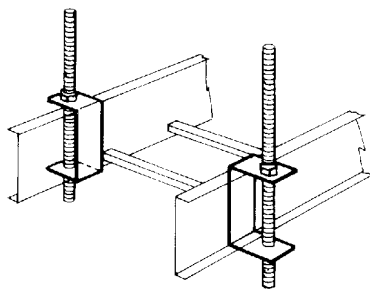


Figure 3-10—Single Cable Tray Hanger Clip

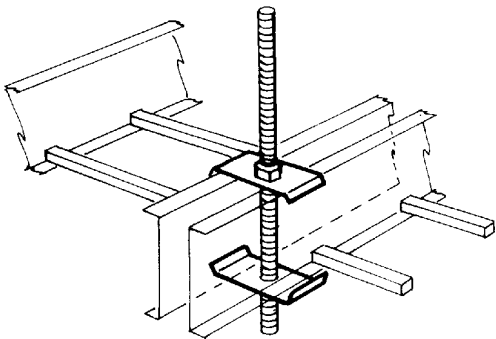


Figure 3-11—Double Cable Tray Hanger Clip

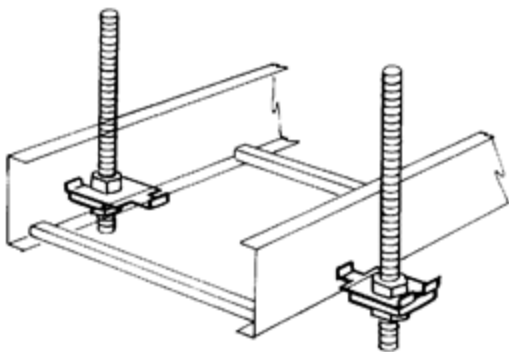


Figure 3-12—Single Cable Tray Hanger Clip

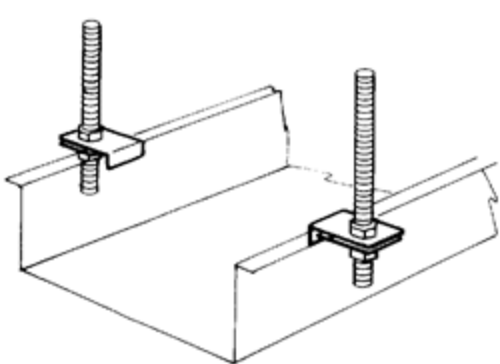


Figure 3-13—Flange mount Cable Tray Hanger Clip

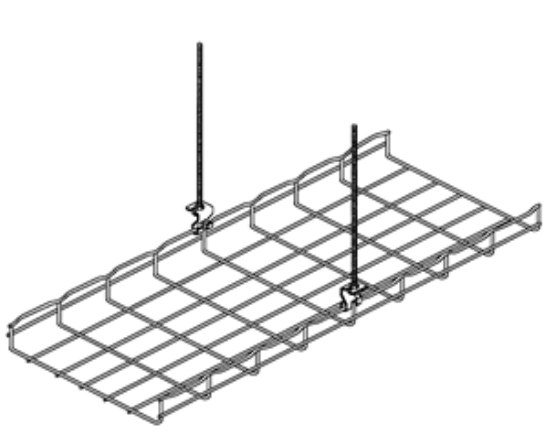


Figure 3-8—Wire Basket Tray Hanger Clip

3.3.3 Center Hung Support

Center hung supports consist of a horizontal member under the cable tray with a center vertical attachment to the structure above (see 3.3, Note 3). For examples, see Figure 3-15 and Figure 3-16. To install:

- a. Thread the nut onto the threaded rod approximately 225 mm (9 in) above the desired location for the bottom of the cable tray.
- b. Slide the washer and support onto the threaded rod with an upright tube going through the center of the cable tray section needing support.
- c. Place a square washer on the threaded rod and thread on the second nut.
- d. Move the cross member so its top surface is located at the place where the bottom of the cable tray run will be located.
- e. Move the second nut up the threaded rod until it reaches the cross member and holds it in place.
- f. Move the first nut down the threaded rod until it secures the cross member in place.

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

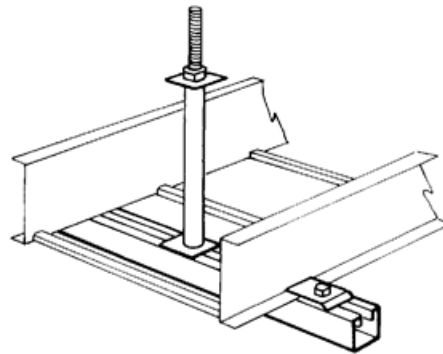
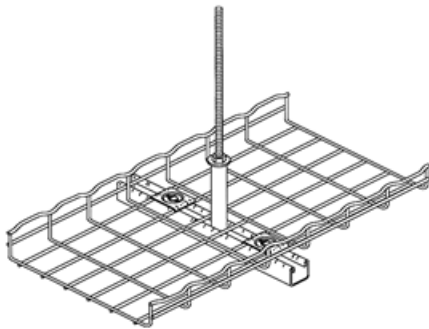


Figure 3-15—Center Hanger Support

Figure 3-9—Center Hanger Support

3.3.4 Single Channel Cable Tray Hanger

These types of supports are C-shaped and have a horizontal support that supports channel cable tray and a vertical attachment to the structure above. For an example, see Figure 3-17. To install:

- a. Thread the nut onto the threaded rod to the height required.
- b. Place the hanger on the threaded rod and follow with one nut.
- c. Run the nut up the threaded rod until the bottom of the hanger is at the desired height.
- d. Run the top nut down to tighten.
- e. Place channel on the hanger, and secure in place as necessary.

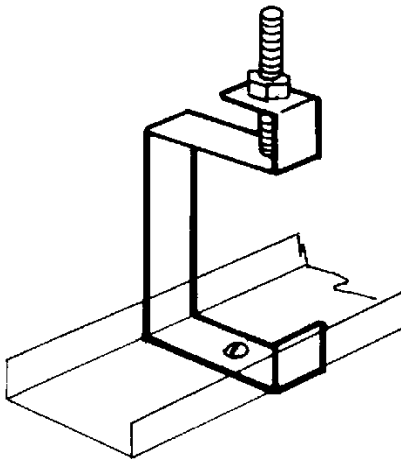


Figure 3-10—Single Channel Hanger

3.3.5 Double Channel Cable Tray Hanger

For an example, see Figure 3-18. To install:

- a. Thread the nut onto the threaded rod to the height required.
- b. Place the hanger on the threaded rod and follow with one nut.
- c. Run the nut up the threaded rod until the bottom of the hanger is at the desired height.
- d. Run the top nut down to tighten.
- e. Place channels on the hanger, and secure in place as necessary.

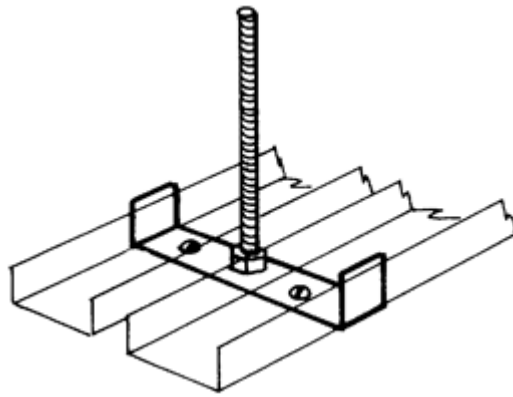


Figure 3-18—Double Channel Hanger

3.3.6 Single-Rail Cable Tray Hangers

For examples, see Figure 3-19 through Figure 3-21Error! Reference source not found.. To install:

- a. Thread the nut onto the threaded rod to the height required.
- b. Place the hanger or cable tray on the threaded rod and follow with one nut.
- c. Run the nut up the threaded rod until the bottom of the hanger or cable tray is at the desired height.
- d. Run the top nut down to tighten.
- e. Place the cable tray in the hanger, and secure in place as necessary.

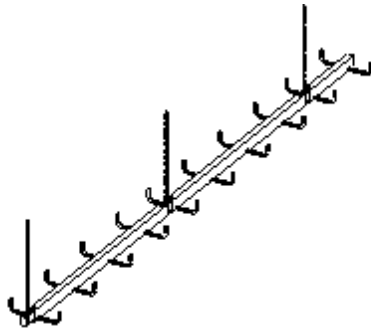


Figure 3-19—Multiple Splice Support

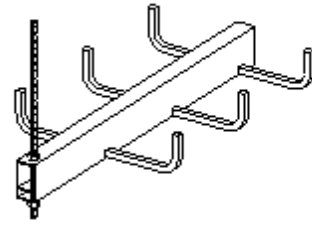


Figure 3-20—Rod Through Spine Hanger

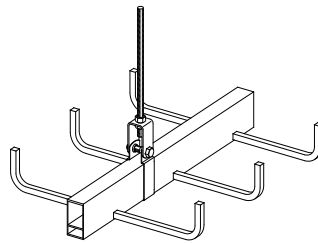


Figure 3-21—Clevis Hanger

3.3.7 Wall and Cantilever Brackets

These types of brackets have a horizontal support under the cable tray and are mounted to the wall or structure from a single side of the horizontal support (see 3.3, Note 3). For examples, see Figure 3-22 through Figure 3-28. Secure the brackets to the structure, making sure they are level and aligned with each other.

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

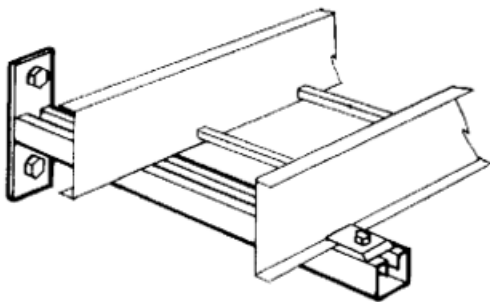


Figure 3-22—Single Strut Cantilever Bracket

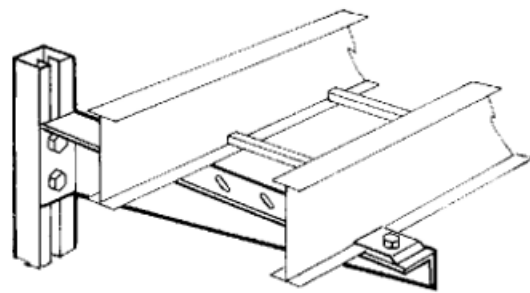


Figure 3-23—Gusset Cantilever Bracket

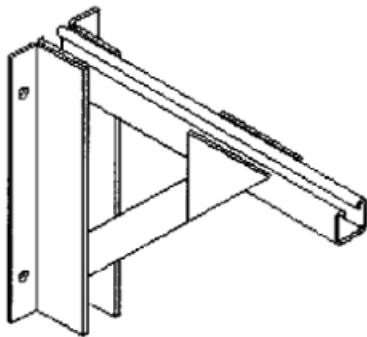


Figure 3-24—Fiberglass Cantilever Bracket

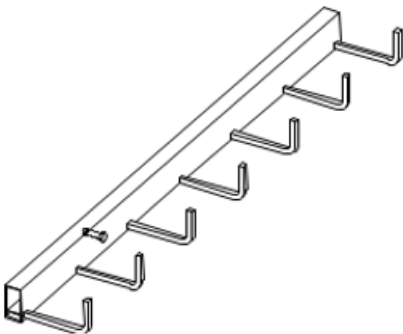


Figure 3-25—Single-Rail Direct Wall Mount

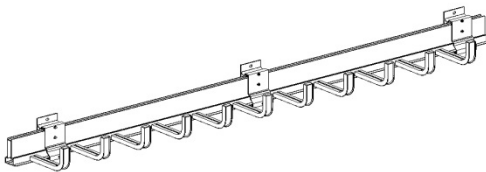


Figure 3-26— Single-Rail Clamp Wall Mount

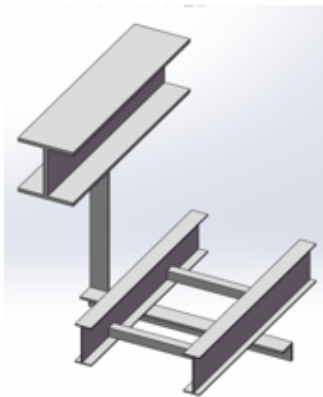


Figure 3-27—Below I-Beam Support

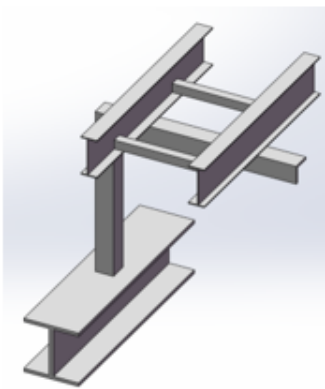


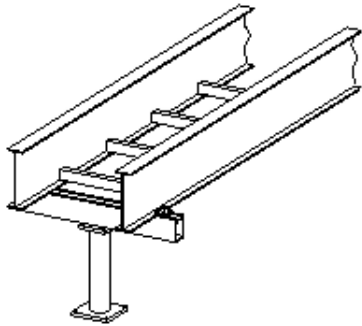
Figure 3-28—Above I-Beam Support

3.3.8 Floor and Roof Installations

For examples, see Figure 3-29 through Figure 3-32. 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

714 the cable tray. If a strut is used for this purpose, mount the strut directly to the floor or roof, and attach the
715 cable tray to the strut using hold-down clamps and/or guide clamps.

716 In most cases, hold-down/guide clamps may be mounted on either the inside or outside of the cable tray.
717 When installed on the inside of the cable tray, the clamp and/or attaching hardware should not extend into
718 the cable pathway.



719
720 **Figure 3-29— Elevated Strut-Type Support**

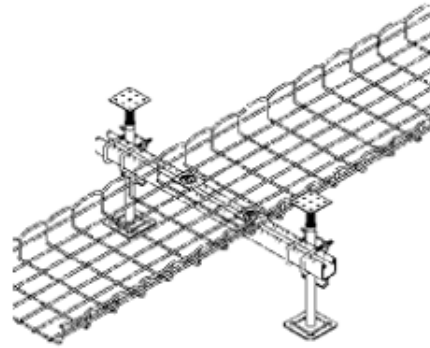
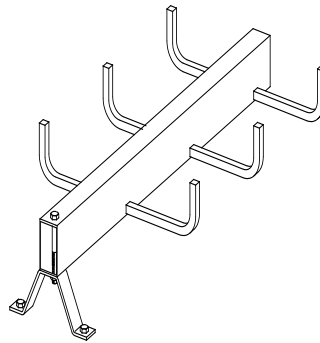


Figure 3-30—Underfloor Support Attached to Floor Pedestals



722
723 **Figure 3-31—Single-Rail Floor Support**

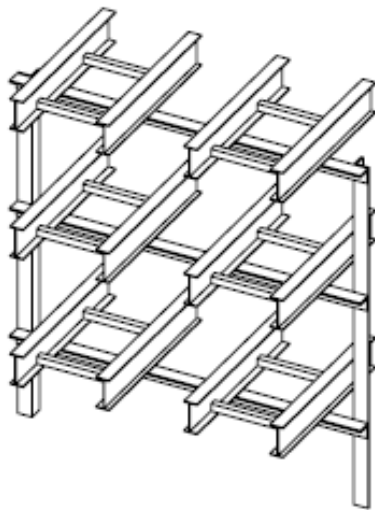


Figure 3-32—Multi-Tier Rigid Support

3.3.9 Vertical Installations

Similar to horizontal-type applications, vertical cable trays should be adequately supported. For examples, see Figure 3-33 through Figure 3-36. The cable tray should be supported on both the left- and right-side rails to the wall or support structure with appropriate hold-down clamps. Cable trays less than 12 ft in length should be supported in a minimum of one location; and trays over 12 ft in length should be supported at a minimum of two locations. The cables should be secured to the rungs of the cable tray (see Section 4.6.b). Cable supports should be evenly spaced to distribute the load across the rung length. The vertical cable load should not be supported solely by the rungs on the top section of the run, but should be distributed evenly throughout the riser. For cable trays without rungs, contact the manufacturer for cable support guidance.

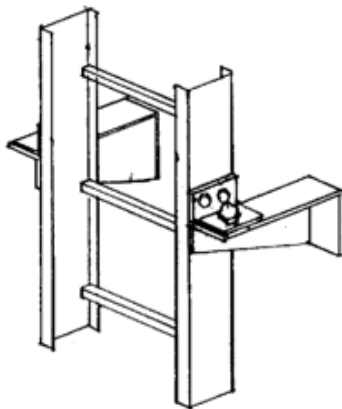
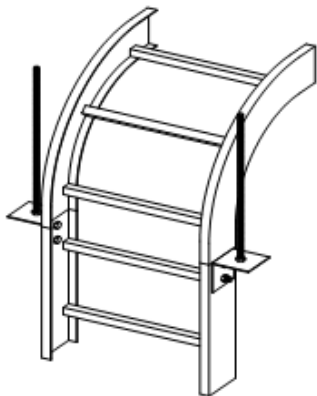


Figure 3-33—Vertical Threaded Rod Support Figure 3-34—Vertical Gusset Cantilever Support

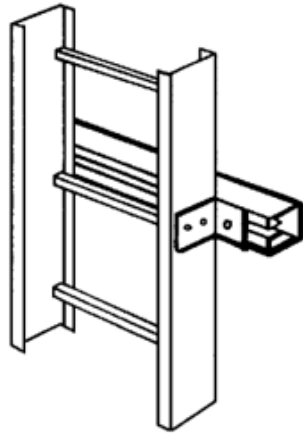


Figure 3-35—Vertical Strut Support

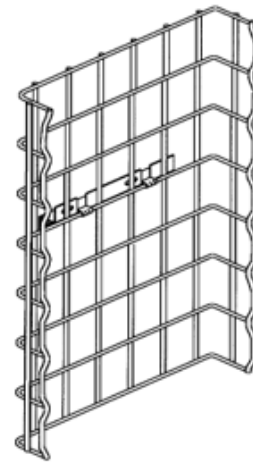


Figure 3-36—Vertical Wall Support

3.3.10 Transverse Installations

For examples, see Figure 3-37 and Figure 3-38. Similar to horizontal-type applications, transverse cable tray should be adequately supported. This is accomplished by securing the upper and lower rails to the wall or support structure with appropriate hold-down clamps. The cables should be secured to the rungs of the cable tray and evenly spaced to distribute the load across the rung length. The cable should not be allowed to collect or group along the bottom rail.

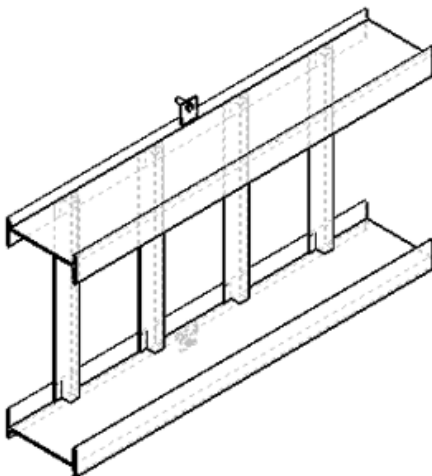


Figure 3-37—Horizontal Tray Mount

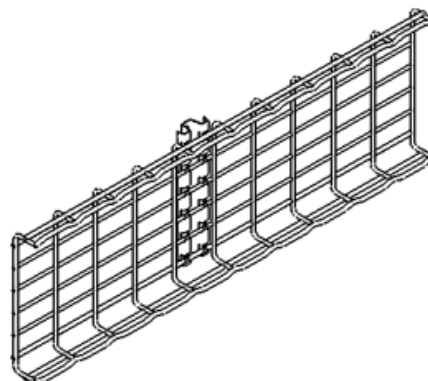


Figure 3-38—Horizontal Wall Support

3.4 Straight Section Installation

Use the torque data in Table 3-1 for fasteners. Follow the manufacturer's recommendations for nonmetallic or nonferrous fasteners. Torque values do not apply for hollow sections, such as tubes. Consult the manufacturer for recommendations.

Table 3-1—Fastener Torque

Inch: GRD. 2 UNC		Metric: Class 5.8	
Size	Ft-Lbs	Size	N-m
1/4 – 20	4-6	M8 x 1.25	14-16
3/8 – 16	17-23	M10 x 1.5	26-33
1/2 – 13	42-56	M12 x 1.78	45-58

Notes:

- a. Threads are not lubricated.
- b. Fastener finishes: zinc-plated, , stainless steel, and other corrosion resistance finishes

3.4.1 Straight Section Position

After the supports are in place, cable tray installation can begin at any convenient point. It is not necessary to start at one end of the run. Splice joints should be designed and placed so as to maximize the rigidity of the cable tray. Unless splice plates are part of a system specifically designed for other placement, including over supports or mid-span, it is ideal to lay out the system so that splice joints fall between the support and the quarter point (see Figure 3-39). When installing a 12-ft-long section, for example, a support spacing of 3.7 m (12 ft) causes the splice joints to fall at the same position every time.

For single-rail cable tray, see Figure 3-19, Figure 3-25, and Figure 3-26.

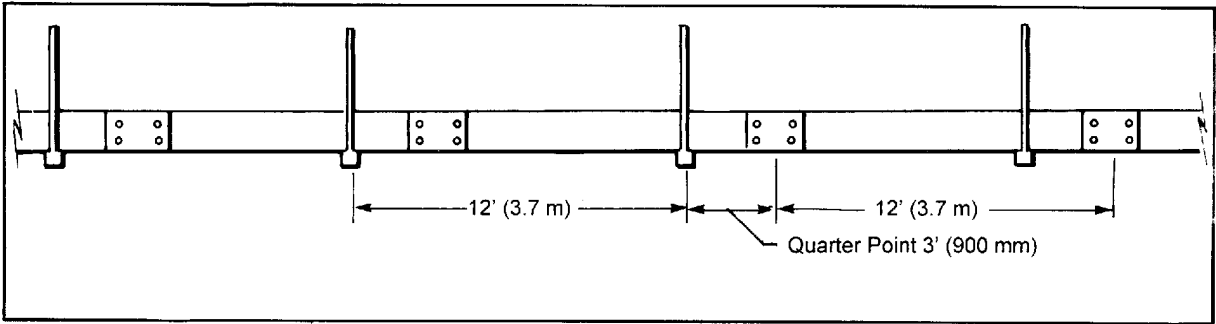


Figure 3-39—Cable Tray Support Locations

To begin, place a straight section across two supports so that the ends of the section are not directly on the support (see Figure 3-40). If the support span is equal to the length of the straight sections, bolt two pieces together for this step (see Figure 3-41). **The support span should not be greater than the straight section length, or as recommended by the manufacturer, to ensure that no more than one splice is located between supports.** Certain cable tray systems (see Figure 3-19) and certain splice designs allow for random splice location. See the manufacturer for details.

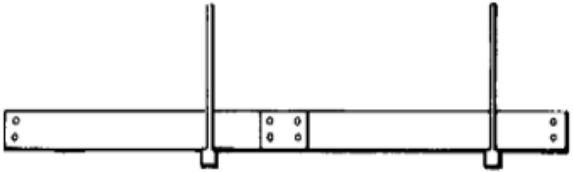


Figure 3-40—Cable Tray Installation

Figure 3-41—Cable Tray Splice Joint Installation

Place the next straight section across the next support, and attach it to the previous section with a pair of splice plates and hardware. The maximum tray overhang past the last support should not exceed 600 mm (2 ft). Splice plates should be placed on the outside of the cable tray, unless otherwise specified by the manufacturer, with the bolt heads on the inside of the cable tray (see Figure 3-42).

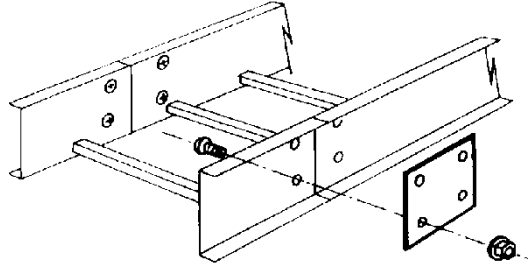


Figure 3-42—Splice Plate Attachment

3.4.2 Expansion Splice Plates

It is important to consider thermal contraction and expansion 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 3-2 and, for an example, Figure 3-).

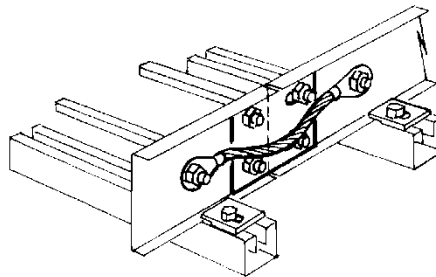


Figure 3-43—Expansion Splice Plate Attachment

Note: In Figure 3-43, a bonding jumper is not required for fiberglass cable tray systems.

Table 3-2—Maximum Spacing between Expansion Joints that Provide for 25.4 mm (1 in) Movement**

Temperature Differential*		Steel		Aluminum		Fiberglass	
°C	(°F)	m	(ft)	m	(ft)	m	(ft)
14	(25)	156	(512)	79	(260)	203	(667)
28	(50)	78	(256)	40	(130)	102	(333)
42	(75)	52	(171)	27	(87)	68	(222)
56	(100)	39	(128)	20	(65)	51	(167)
70	(125)	31	(102)	16	(52)	41	(133)
83	(150)	26	(85)	13	(43)	34	(111)
97	(175)	22	(73)	11	(37)	29	(95)

* Temperature differential is the difference in temperature between the hottest and coldest days of the year. Temperature differential for Fahrenheit is calculated by 9/5th of the Celsius.

** For designs that provide for 16 mm (5/8 in.) movement (typically nonmetallic), multiply maximum spacing between expansion joints by 0.625.

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 3-44). The cable tray should be permitted longitudinal movement in both directions from that fixed point.

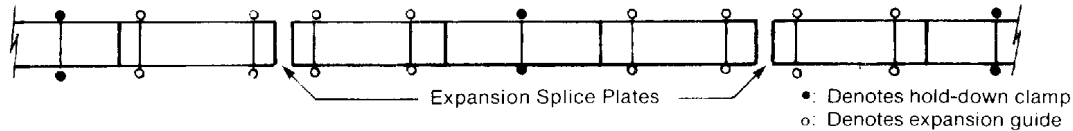


Figure 3-44—Hold-down and Guide Clamp Locations

Accurate gap setting at the time of installation is necessary for proper operation of the expansion splice plates. The following procedure should assist the installer in determining the correct gap (see Figure 3-40):

- Plot the highest expected temperature on the maximum temperature line.
Example value = 38°C (100°F)
- Plot the lowest expected temperature on the minimum temperature line.
Example value = -33°C (-28°F)
- Draw a line between the maximum and minimum points.
- Plot the temperature at the time of installation to determine the gap setting.
Example value = 9.5 mm (3/8 in), 10°C (50°F).

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 one-half turn. For other types of hardware, follow the manufacturer's instructions.

Metal cable tray expansion joints require bonding for electrical continuity. Refer to Section 3.8 for bonding jumper installation (see Figure 3-43).

Supports should be located within 600 mm (2 ft) of each side of the expansion splice plates. Expansion splice joints should be designed and placed so as to maximize the rigidity of the cable tray, unless expansion splice plates are part of a system specifically designed for other placement, including over supports, quarter-span, or mid-span.

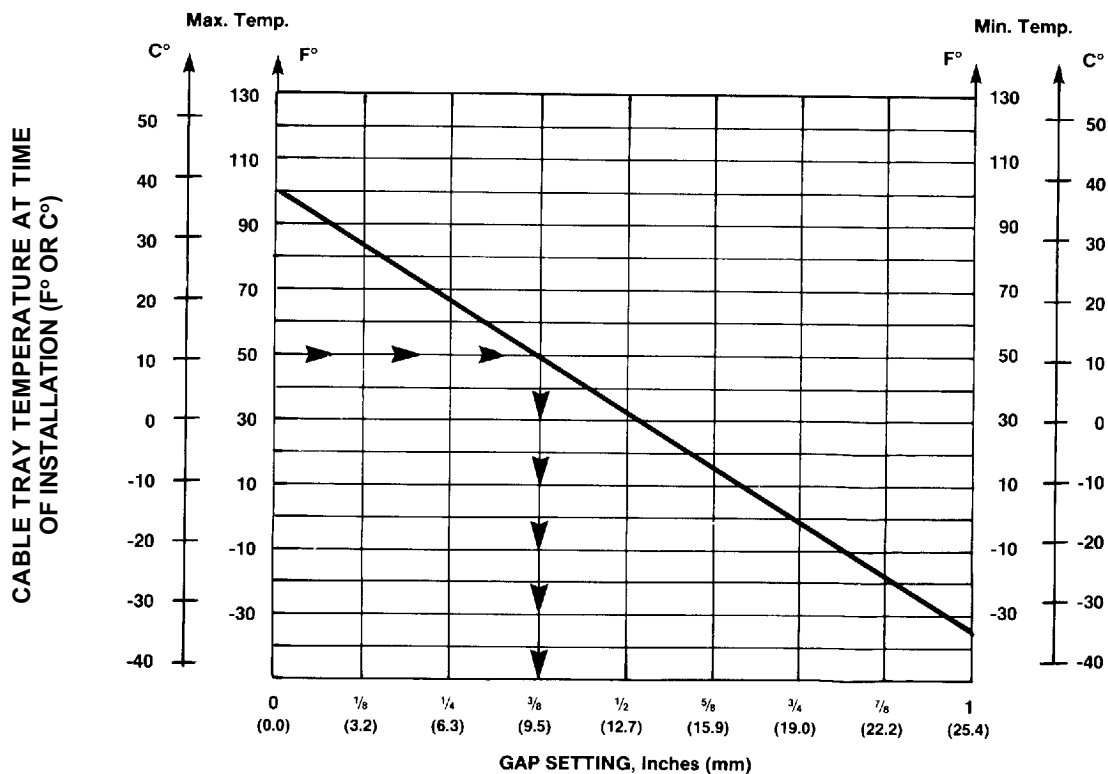


Figure 3-45—Gap Setting of Expansion Splice Plate—25.4 mm (1 in.) Gap Maximum*

*For designs using 15.9 mm ($\frac{5}{8}$ in.) maximum gap (typically nonmetallic), multiply gap setting by 0.625.

Note: For extended vertical runs, see Section 3.5.2.

3.4.3 Vertical Adjustable Splice Plates

For examples, see Figure 3-46 and Figure 3-47. For changes in vertical direction not requiring a radius, vertical adjustable splice plates can be used. Supports should be located within 600 mm (2 ft) of each side of vertical adjustable splice plates.

Vertical adjustable splice plates should be designed and placed so as to maximize the rigidity of the cable tray, unless vertical adjustable splice plates are part of a system specifically designed for other placement, including over supports or mid-span:

- Position splice halves so that offsets adjust for material thickness, and fasten with a nut and bolt using hole (A).
- Attach to positioned cable tray sections, which sets the needed angle.
- Drill to complete hole (B) (Figure 3-41 only).
- Insert and tighten all hardware.

For metal cable tray, bonding jumpers are required for electrical continuity, unless the splice plates meet the electrical continuity requirements of NEMA VE 1, Section 4.7. Also, see Section 3.8.

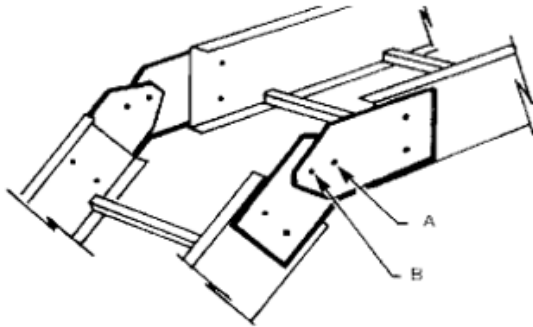


Figure 3-46—Two-Bolt Vertical Adjustable Splice Plates

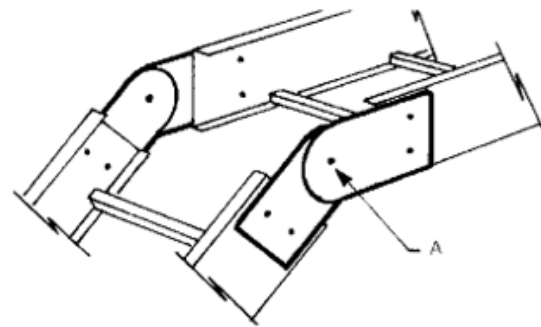


Figure 3-47—Single-Bolt Vertical Adjustable Splice Plates

3.4.4 Horizontal Adjustable Splice Plates

For changes in horizontal direction not requiring a radius, horizontal adjustable splice plates can be used. Supports should be located within 600 mm (2 ft) of each side of horizontal adjustable splice plates (see Figure 3-43).

Horizontal adjustable splice plates should be designed and placed so as to maximize the rigidity of the cable tray, unless horizontal adjustable splice plates are part of a system specifically designed for other placement, including over supports or mid-span:

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

For metal cable tray, bonding jumpers are required for electrical continuity unless the splice plates meet the electrical continuity requirements of NEMA VE 1, Section 4.7, "Bonding".

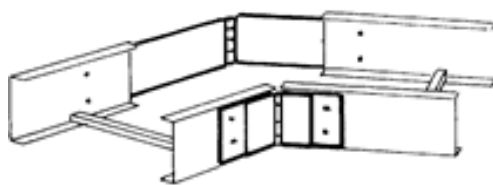
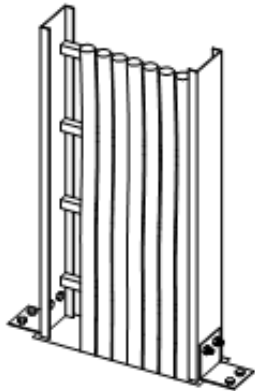


Figure 3-48—Horizontal Adjustable Splice Plates

3.4.5 Cable Tray to Box or Floor Splice Plates

For examples, see Figure 3-49 and Figure 3-50 (for termination of cable tray systems to equipment or structures).

Cable trays and/or cable penetrations through partitions, walls, floors, and ceilings often require special fire rating or environmental concerns, and should be handled in accordance with NEC Articles 392 and 300.



**Figure 3-49—Cable Tray to Box/
Floor Splice Plates**

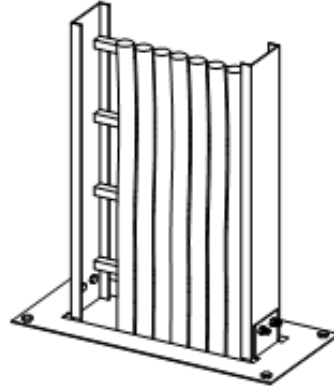


Figure 3-50—Cable Tray to Box Connector

3.4.6 Offset-Reducing Splice Plates

For immediate width changes, use offset-reducing splice plates. Supports should be located within 600 mm (2 ft) of each side of offset-reducing splice plates (see Figure 3-51):

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

Offset-reducing splice plates should be designed and placed so as to maximize the rigidity of the cable tray, unless offset-reducing splice plates are part of a system specifically designed for other placement, including over supports or mid-span.

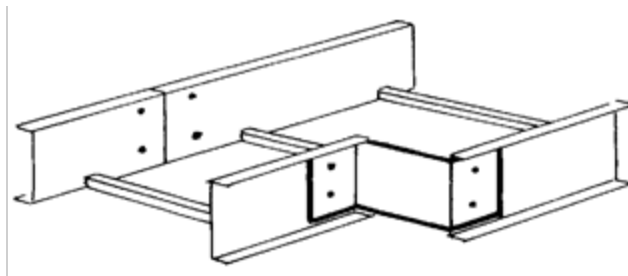


Figure 3-51—Offset-Reducing Splice Plate

3.4.7 Vertical Support Hangers

For an example, see Figure 3-52. Use vertical support for additional support of extended vertical runs (see Section 3.3.4).

3.4.8 Step-down Splice Plates

For an example, see Figure 3-53. Use step-down splice plates when connecting cable trays of different heights. Step-down splice plates should be designed and placed so as to maximize the rigidity of the

cable tray, unless step-down splice plates are part of a system specifically designed for other placement, including over supports or mid-span.

3.4.9 End Plates

For an example, see Figure 3-54. For dead-end closure indicating termination of cable tray run, use end plates.

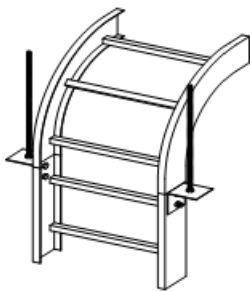


Figure 3-52—Vertical Support Hangers

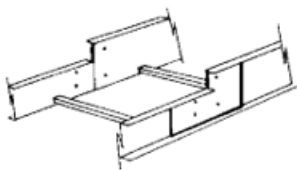


Figure 3-53—Step-down Splice Plates

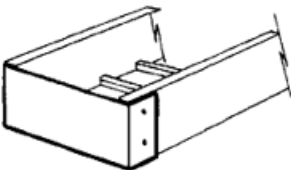


Figure 3-54—End Plate

3.4.10 Single-Rail Cable Tray Fitting Connectors

For examples, see Figure 3-55 through Figure 3-58. Single-rail cable trays typically use connector plates in lieu of radius fittings.

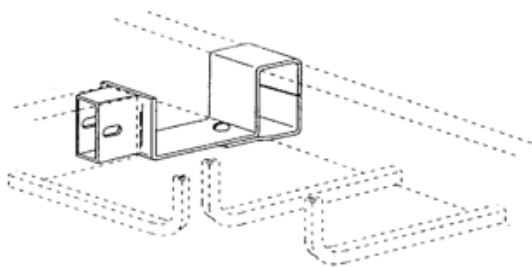


Figure 3-55—Horizontal Tee or 90° Connector

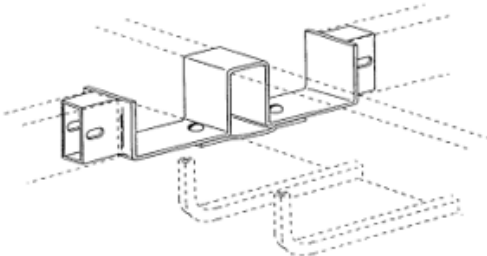


Figure 3-56—Horizontal Cross Connector

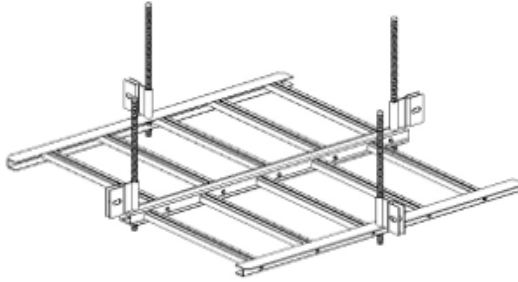


Figure 3-57—Horizontal Hub

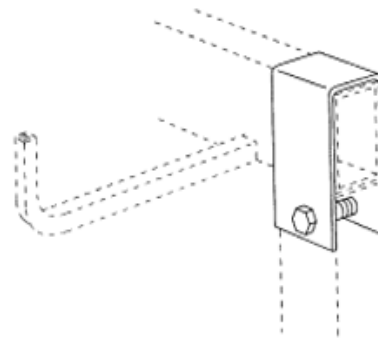


Figure 3-58—Vertical Tee or 90° Connector

3.5 Fittings Installation

See Section 3.5.3 for single-rail and wire mesh cable trays.

3.5.1 Recommended Support Locations for Fittings

Recommended support locations follow, unless otherwise recommended by the manufacturer.

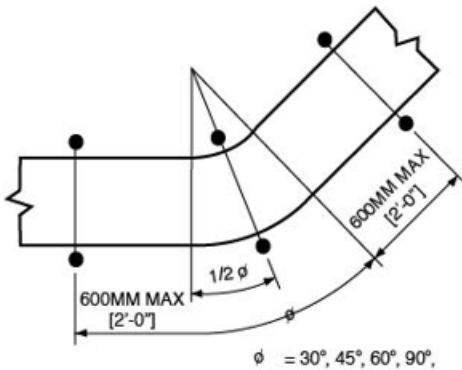
3.5.1.1 Horizontal Elbow Support

For an example, see Figure 3-59. Supports for horizontal cable tray fittings should be placed within 600 mm (2 ft) of each fitting extremity, and as follows:

- a. 90° supports at the 45° point of arc;
- b. 60° supports at the 30° point of arc;
- c. 45° supports at the 22½° point of arc (except for the 300 mm (12 in.) radii);
- d. 30° supports at the 15° point of arc (except for the 300 mm (12 in.) radii).

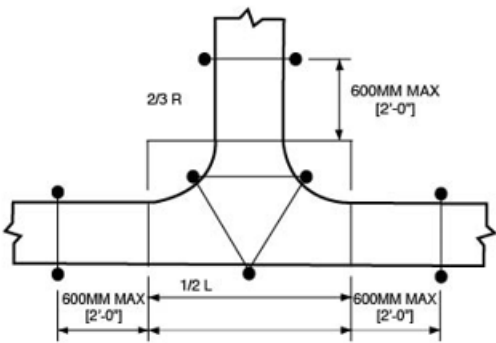
3.5.1.2 Horizontal Tee Support

For an example, see Figure 3-60. Place horizontal tee supports within 600 mm (2 ft) of each of the three openings connected to other cable tray items for the 300 mm (12 in.) radius. On all other radii, at least one additional support should be placed under each side rail at the horizontal tee, preferably as shown.



CENTER SUPPORT NOT REQUIRED
ON 12" RADIUS 30° & 45° FITTINGS

Figure 3-59—Horizontal Elbows



CENTER SUPPORT NOT REQUIRED ON 12" RADIUS FITTINGS

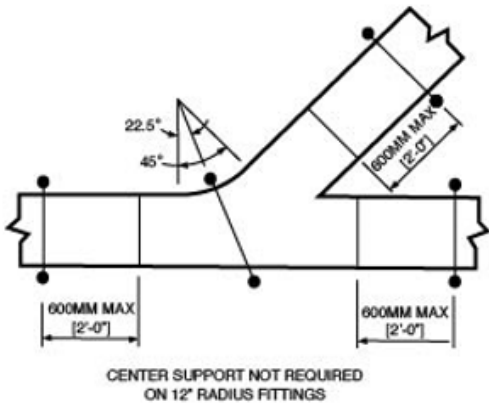
Figure 3-60—Horizontal Tee

3.5.1.3 Horizontal Wye Support

For an example, see Figure 3-61. Place the horizontal wye support within 600 mm (2 ft) of each of the three openings connected to other cable tray items, and at the $22\frac{1}{2}^\circ$ point of the arc adjacent to the side branch.

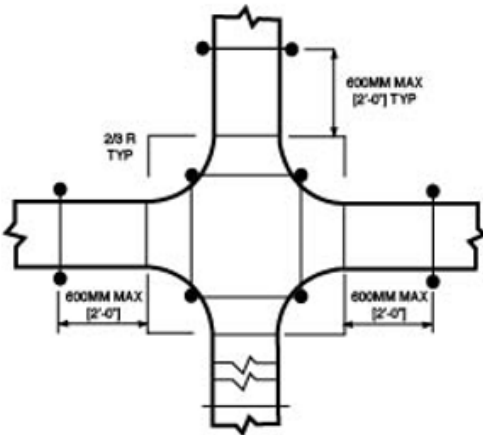
3.5.1.4 Horizontal Cross Support

For an example, see Figure 3-62. Place the horizontal cross support within 600 mm (2 ft) of each of the four openings connected to other cable tray items for the 300 mm (12 in.) radius. On all other radii, at least one additional support should be placed under each side rail of the horizontal cross, preferably as shown.



CENTER SUPPORT NOT REQUIRED
ON 12" RADIUS FITTINGS

Figure 3-61—Horizontal Wye



CENTER SUPPORT NOT REQUIRED ON 12" RADIUS FITTINGS

Figure 3-62—Horizontal Cross

3.5.1.5 Reducer Support

For an example, see Figure 3-63. Place reducer supports within 600 mm (2 ft) of each fitting extremity.

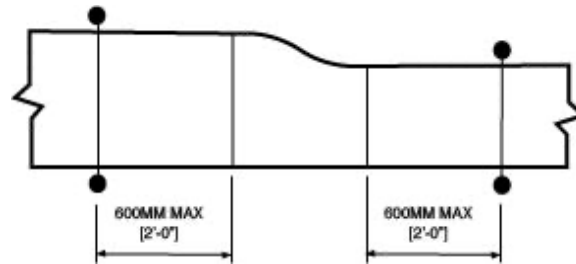


Figure 3-63—Right Hand Reducer

3.5.1.6 Vertical Cable Tray Elbows

For an example, see Figure 3-64. 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 600 mm (2 ft) of the lower extremity of the elbows.

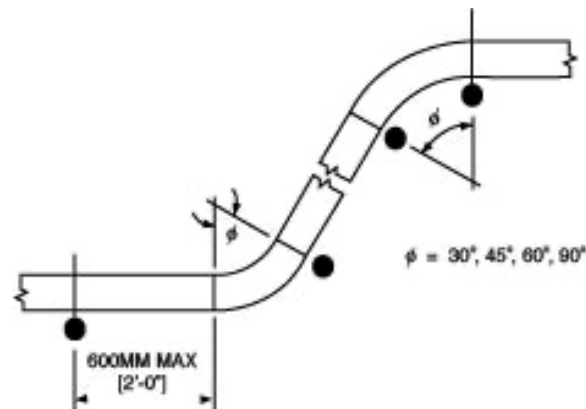


Figure 3-64—Vertical Elbows (Side View)

3.5.1.7 Vertical Cable Tray Tees

For an example, see Figure 3-65. Vertical cable tray tees should be supported within 600 mm (2 ft) of each fitting extremity.

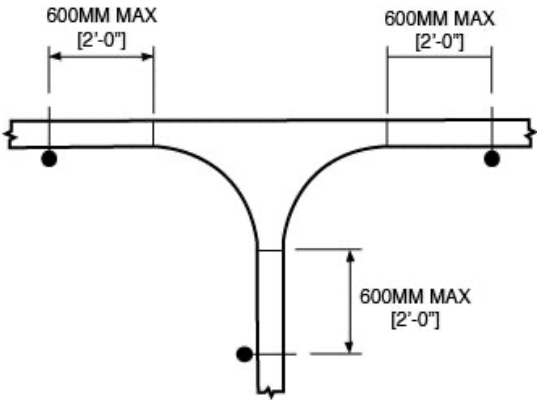


Figure 3-65—Vertical Tee (Side View)

3.5.2 Extended Vertical Runs

3.5.2.1 Cable Support Fittings

For examples, see Figure 3-66 and Figure 3-67. These fittings are recommended for use at the top of long vertical runs of heavy cable to support the cables.

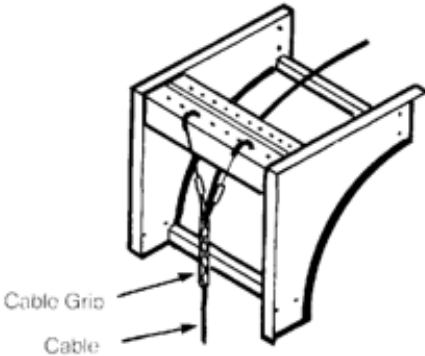


Figure 3-66—Vertical Cable Support

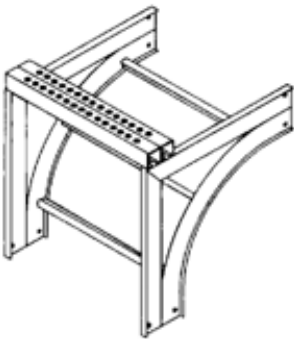


Figure 3-67—Vertical Cable Support

3.5.2.2 Securing and Allowing for Expansion

Extended vertical runs of cable tray that require accommodation for expansion may require installation modifications. If the system is outdoor and is supporting a sizable cable load, each section of cable tray may need to be securely attached to the structure with heavy-duty bolt-through hold-down clamps. Bolt-through hold-down clamps of this type should anchor each cable tray section. Sections should be spaced apart (similar to the horizontal spacing provisions as identified in Figure 3-45) enough to allow for any possible expansion, and should be grounded using bonding jumpers connected to each section (see Figure 3-43).

3.5.3 Recommended Support Locations for Single-rail and Wire Mesh Cable Trays

Single-rail and wire mesh cable trays have alternate support configurations. Consult the manufacturer for details.

3.6 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.

Cable tray field modifications shall be made by qualified personnel only.

3.6.1 Marking

For examples, see Figure 3-68 and Figure 3-69. Using a square that reaches across the width of the cable tray, gauge off the edge of one side rail and mark both flanges (see Figure 3-68). Next, position the square as shown in Figure 3-69 and mark the web of the rail. Marking can be done with a scribe, marking pen, or a pencil.

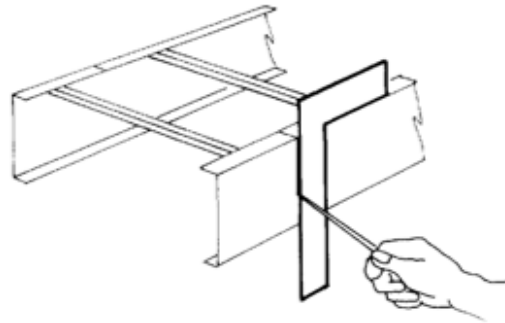
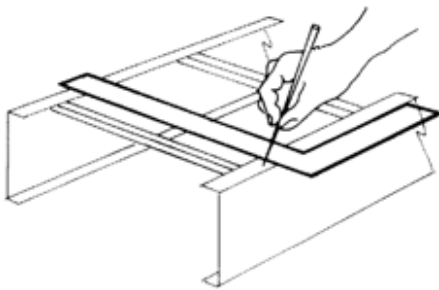


Figure 3-68—Marking the Flanges

Figure 3-69—Marking the Web of the Rail

3.6.2 Cutting

The cut can be made using a hand-held hacksaw, a circular saw with carbide-tip or diamond-dusted blade, a hand-held band saw, offset bolt cutters, or a high-speed grinder (for wire mesh only). 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 (see Figure 3-78 through Figure 3-80).** After cutting, smooth the cut edges to remove any burrs. Fiberglass material should be cut with a circular saw with a carbide tip or a diamond-dusted blade.

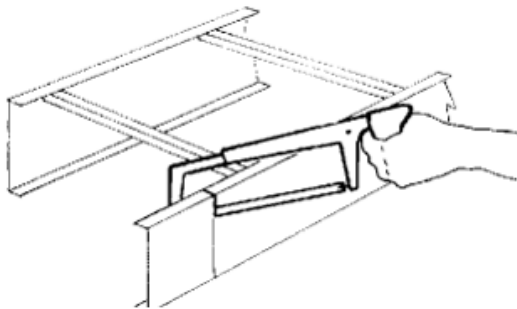


Figure 3-70—Cutting with Hand-held Hacksaw



Figure 3-71—Marking the Web of the Rail

For examples of correct cut, correct blades to use, and correct blade placement, see Figure 3-72 through Figure 3-74.



Figure 3-72—Correct Cut



Figure 3-73—Correct Blades to Use

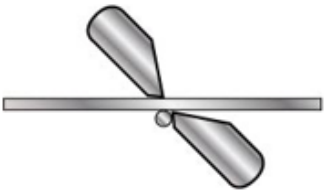


Figure 3-74—Correct Blade Placement

For examples of incorrect cut, incorrect blades to use, and incorrect blade placement, see Figure 3-75 through Figure 3-77.



Figure 3-75—Incorrect Cut



Figure 3-76—Incorrect Blades to Use

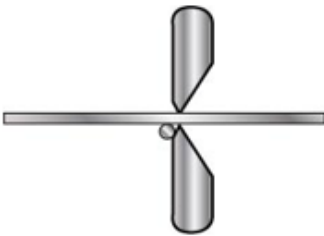


Figure 3-77—Incorrect Blade Placement

3.6.3 Drilling

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 (see Figure 3-78) 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 (see Figure 3-79). Clamp the splice plate to the rail, and drill through the splice plate holes and the side rail (see Figure 3-80). The correct drill size depends on the hardware supplied with the cable tray. Match the holes that exist in the cable tray. After drilling, remove burrs.

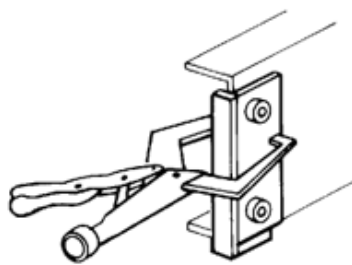


Figure 3-78—Drilling with Drill Jigs

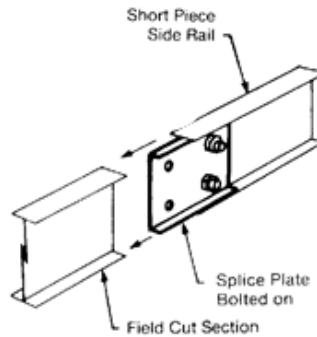


Figure 3-79—Drilling with Punched Side Rail

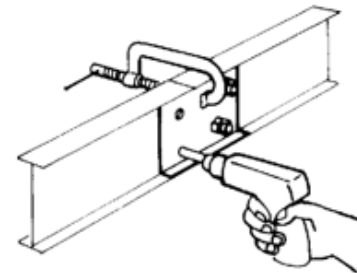


Figure 3-80—Drilling with Clamp and Side Rail

3.6.4 Finish Touch-up

H.D.G.A.F. cable trays need to be retouched after cutting, drilling, or deburring, or if the coating becomes 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 cable trays do not need to be touched-up.

Touch-up of the galvanized finish must be done according to ASTM A780. Use an approved zinc-rich galvanizing material that meets the requirements of ASTM A780. If it is not noted on the product label as to whether the material meets ASTM A780, the material specification sheet should be obtained from the galvanizing material supplier. The paint can be applied by brushing or spraying. Always paint 13 mm (1/2 in.) to 25 mm (1 in.) beyond the bare area to prevent undercutting by corrosion.

After cutting or drilling fiberglass cable trays, seal the cut edges with the manufacturer's recommended sealant.

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

3.6.5 Wire Mesh Fittings Fabrication

For examples, see Figure 3-81. Fittings may be field-fabricated from straight sections on-site with an offset bolt cutter and wrench, or a high-speed grinder. Care shall be taken if a wire mesh tray's cross-sectional area changes as a result of field fabrication. All manufacturer instructions, as well as additional requirements for bonding and grounding, shall be followed.

Horizontal or vertical bends, tees, and crosses are fabricated by notching out segments of side-rail grids, and overlapping and connecting parallel wires by means of a connector.

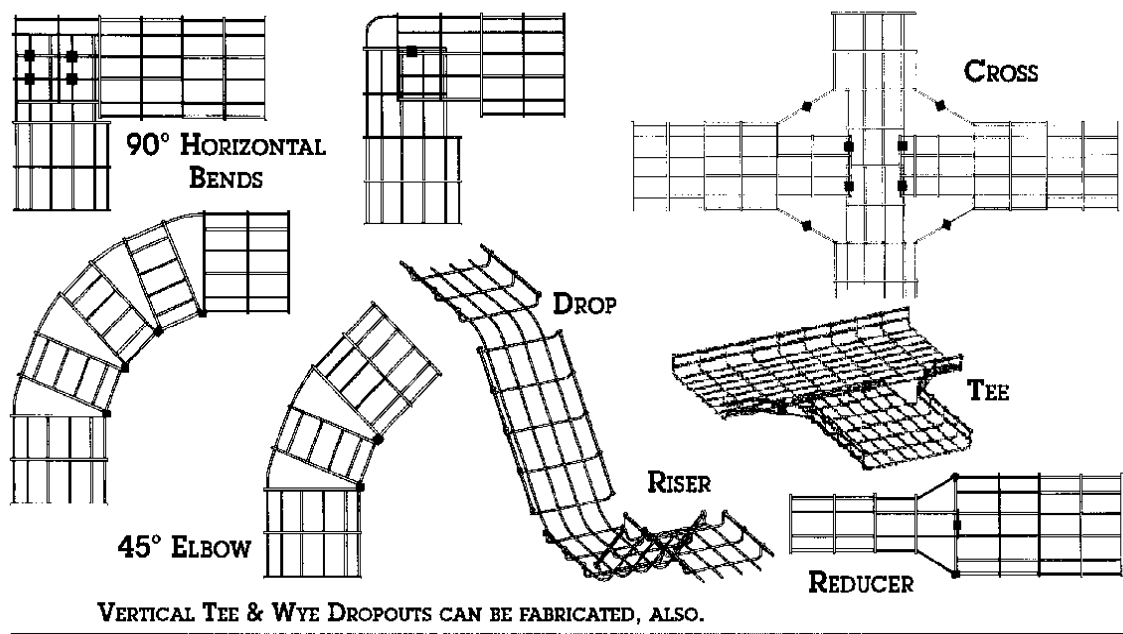


Figure 3-81—Typical Wire Mesh Fittings—Field-fabricated

3.7 Accessories

3.7.1 Barrier (Divider) Strips

For examples, see Figure 3-82 through Figure 3-84.



Figure 3-82—Barrier (Divider) Strip—Straight Section

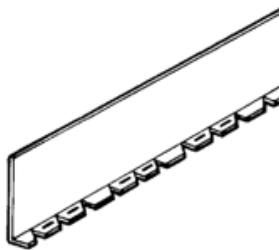


Figure 3-83—Barrier (Divider) Strip—Horizontal Fitting



Figure 3-84—Barrier (Divider) Strip—Vertical Fitting

Barrier (divider) strips are sometimes used to separate cables within a cable tray, as required by the NEC. For an example, see Figure 3-85.

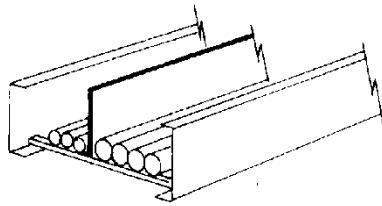


Figure 3-85—Barrier (Divider) Strip Application

Barrier (divider) strips are installed by placing them at the desired location(s), secured with manufacturer recommended methods. For examples, see Figure 3-86 and Figure 3-87. This connection should be made at approximately every 900 mm (3 ft)

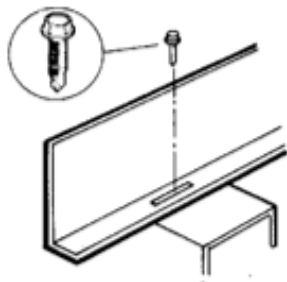


Figure 3-86—Barrier (Divider) Strip Attachment—Self-drilling and Self-tapping Screw

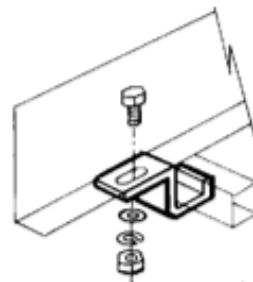


Figure 3-87—Barrier (Divider) Strip Attachment—Clip

Barrier (divider) strips along a cable tray run may be connected using a barrier strip splice. For examples, see Figure 3-88 and Figure 3-89.

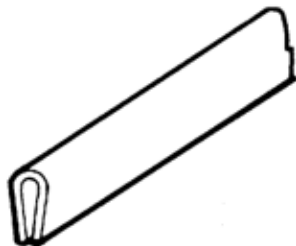


Figure 3-88—Barrier (Divider) Strip Splice

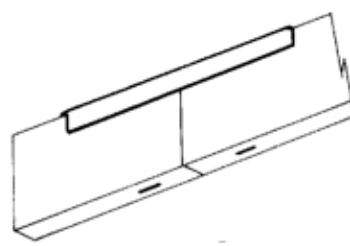
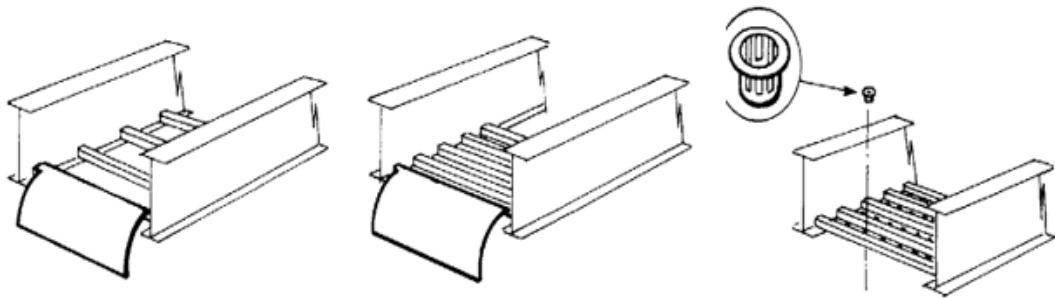


Figure 3-89—Barrier (Divider) Strip Splice—Installed

3.7.2 Drop-Outs

For examples, see Figure 3-90 through Figure 3-92. The drop-outs and drop-out bushings provide a smooth surface to protect the cable insulation as it exits the cable tray.



**Figure 3-90—Ladder
Drop-out**

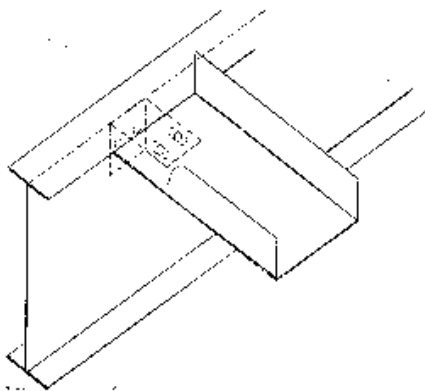
**Figure 3-91—Trough
Drop-out**

**Figure 3-92—Trough
Drop-out Bushing**

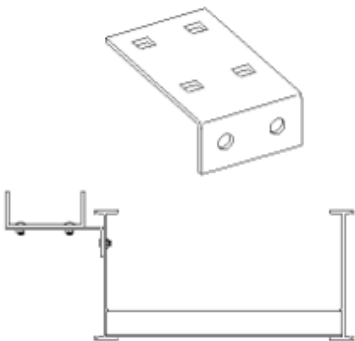
3.7.3 Cable Channel to Cable Tray

Attaching a channel cable tray by using the method illustrated in Figure 3-93 maintains the electrical requirements and the bolted mechanical connection while providing a practical method for dropping tray cables to equipment. Wire mesh systems also may be a wise consideration for supporting cable drops.

A channel cable tray can be added to an existing cable tray system using the method illustrated in Figure 3-94 to add approved cabling systems. Refer to the loading information of the existing cable tray system to confirm that any additional loading will not surpass the stated loading capacity.



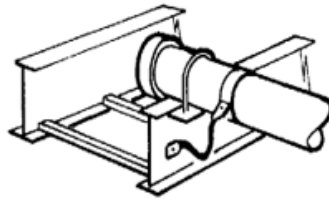
**Figure 3-93—Cable Tray
to Channel**



**Figure 3-94—Channel to Ladder
Tray Bracket**

3.7.4 Conduit to Cable Tray Adapters

For examples, see Figure 3-95 through Figure 3-97. These adapters provide for attachment of conduit that terminates at a cable tray run. If an adapter is not listed, it provides only a mechanical, not an electrical, connection. To make an electrical connection for an adapter that is not listed, an equipment bonding jumper must be run from the conduit to the cable tray. When using a conduit system to exit or enter a cable tray system, verify the proper conductor installation. Tray-rated cables are required for cable tray installation, so using a channel cable tray system or wire mesh system for exits may be more convenient and economical.



**Figure 3-95—Installed
Conduit to Cable Tray
Adapter**



**Figure 3-96—Swivel
Conduit to Cable Tray
Adapter**



**Figure 3-97—Conduit
to Cable Tray Adapter**

3.7.5 Covers and Clamps

Examples of cable tray covers are provided in Figure 3-98.

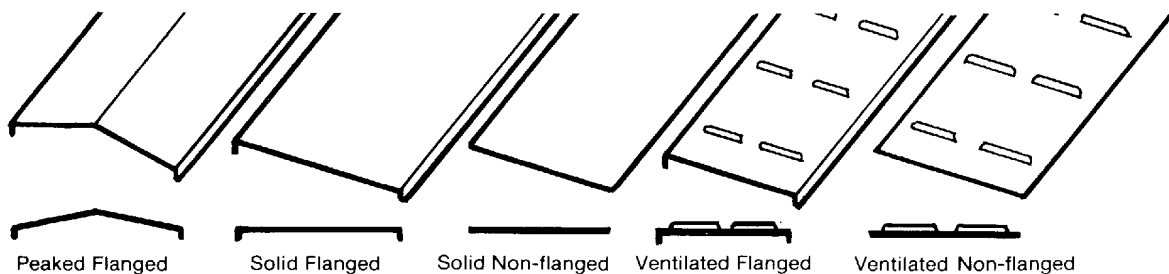


Figure 3-98—Cable Tray Covers

Covers are typically added to a cable tray system when additional cable and personnel protection is required. It is important to consider that tray-rated cables have mechanical and UV protection built into their construction, making the sound use of covers uncommon. It is recommended to install covers the first 1 m (3 ft) of a cable tray system, extending vertically from a floor penetration. If a facility risk analysis identifies that cabling contained in a cable tray needs to be protected from falling debris, cable tray covers should be installed in accordance with the following statements:

- Covers shall be limited to the area of concern.
- Covers shall be limited to the top tier of the tray if the trays are multi-tiered (stacked).
- Covers shall be ventilated to dissipate excess wind pressure or to dissipate heat.
- Covers shall be held with exterior-rated clamps per manufacturer's recommendation.
- If a cable tray system passes an open walkway, the cables should be protected with covers from personnel or possible falling objects in the immediate area.
- Should a cable tray system temporarily be subjected to falling debris, a temporary cover should be used and then removed when no longer necessary.
- Cover installation also has merit in certain environmental air handling area installations. Refer to local codes and installation specifications for project requirements.

Adding covers to a cable tray system may limit access, thus affecting the ability to add, mark, or remove cabling in the future. In the case of power cables, the addition of covers may require that the conductors be de-rated and may affect the loading of the cable tray system.

In general, installing covers on outdoor cable tray systems is not common practice. Should covers be required, proper attachment is required to protect them from wind forces. If covers are desired, it is recommended that they are ventilated to reduce wind pressure.

When specifying covers for a system, review that the material and finish is clearly stated to satisfy the installation need and environment. For examples of cable tray cover clamps and accessories, see Figure 3-99.

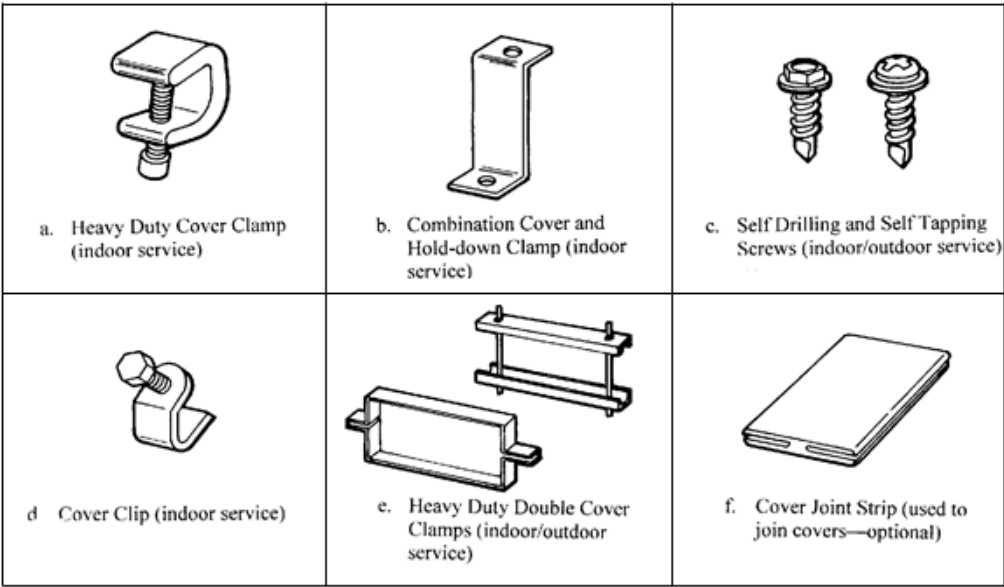


Figure 3-99—Cable Tray Cover Clamps and Accessories

Note: Special consideration should be given to wind loading on outdoor applications.

Table 3-3 provides information on the required spacing for cover clamps.

Table 3-3—Quantity of Standard Cover Clamps Required

Straight section, 1.8 m (6 ft)	4 pieces
Straight section, 3.0 m (10 ft) and 3.7 m (12 ft)	6 pieces
Horizontal/vertical bends	4 pieces
Tees	6 pieces
Crosses	8 pieces

Note: When using the heavy-duty cover clamp shown in Figure 3-99 e., only half the quantity of pieces is required.

3.8 Grounding and Bonding

NEC 392.60 requires that metallic cable trays be grounded and electrically continuous.

In general, non-current-carrying parts of equipment that are likely to become energized are required to be connected to an equipment grounding conductor (EGC). For further information, see NEC 250.96, 250.110, 250.112, and 250.134.

Some manufacturers may recommend bonding and/or grounding of their equipment for other purposes, such as electromagnetic interference (EMI), radio frequency interference (RFI), or electrostatic discharge (ESD).

Cable trays are suitable as EGCs when classified to NEMA BI-50015.

For specific areas requiring bonding for electrical continuity, refer to **Error! Reference source not found.** through **Error! Reference source not found.**.

3.8.1 Cable Tray Used as an Equipment Ground Conductor (EGC)

For examples, see Figure 3-100 through Figure 3-103. Aluminum and steel cable tray, fittings, and connectors are permitted to be used as EGCs in accordance with NEC 392.60 under the conditions specified, if classified and marked with the cross-sectional area. Using Table 3-4, verify that the cross-sectional area of the cable tray, fittings, and connectors are all appropriate for the maximum rating or setting of the overcurrent protection device.

If bonding jumpers are used, or if cable tray connectors are not classified as EGCs, NEC 250.102 specifies bonding jumper sizes.

Note: Stainless steel cable trays are not permitted for use as EGCs. Stainless steel cable trays or stainless steel splice connectors require proper bonding, using manufacturer-recommended methods, per NEC 392.60 and 250.96.

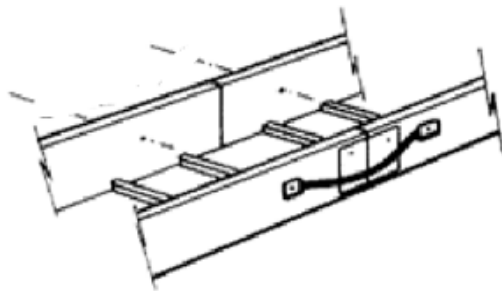


Figure 3-100—Expansion Splice Plates

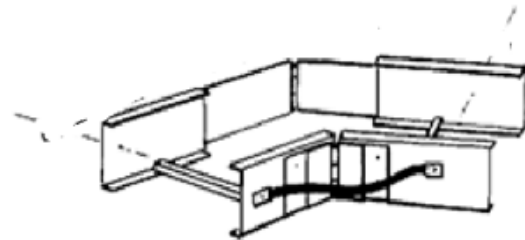


Figure 3-101—Horizontal Adjustable Splice Plates

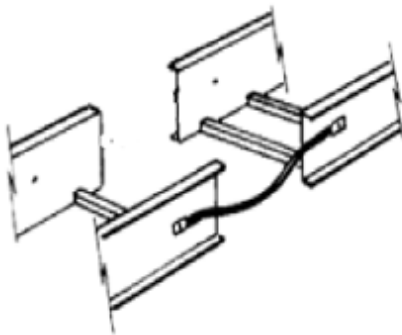


Figure 3-102—Discontinuous

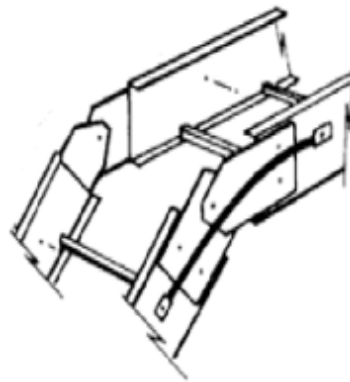


Figure 3-103—Cable Tray Sections Vertical Adjustable Splice Plate

3.8.2 Cable Trays with Wire-Type Equipment Grounding Conductor (EGC) Installed

For an example, see Figure 3-104. When a wire-type EGC is installed in or on a cable tray, it may be bonded to the cable tray with a grounding clamp. Grounding clamp styles include bolted lug types, which require drilling the cable tray side rail, and clamp-on styles that work like a beam clamp. One listed grounding clamp should be used on each section of cable tray. Install a wire-type EGC or bonding jumper at areas where:

- a. the cable tray is not mechanically continuous; or
- b. non-classified connectors are installed; or
- c. gaps surpass the length of traditional bonding jumpers.



Figure 3-104—Grounding Clamps

Bare copper wire-type EGC should not be used in or on an aluminum cable tray. Bonding jumpers are not required if the wire-type EGC is properly bonded to all equipment.

3.8.3 Check for Properly Sized EGC or Bonding Jumpers

3.8.3.1 Power Applications

Bonding jumpers and EGCs are sized according to NEC Articles 250 and 392.

Note: NEC Table 392.60(B) is the actual circuit breaker trip setting, and not the maximum allowable, under the conditions in NEC 240.6. If the maximum ampere rating of the cable tray system is not sufficient for the protective device used, the cable tray system cannot be used as an EGC, and the NEC requires that a wire-type EGC be included in the cable tray system.

3.8.3.2 Non-Power Applications

Cable tray systems containing conductors outside the scope of NEC Article 250 (such as data, communications, signal cables, or others) still require proper bonding and grounding for system operation and performance.

Metal trays containing these conductors shall be electrically continuous via classified connectors or the use of a bonding jumper.

Electrical continuity across field-fabricated wire mesh fittings can be accomplished using classified wire-mesh tray connectors and following the manufacturer's installation instructions.

3.8.3.3 Mixed Systems

When single-conductor power conductors are installed in metallic cable tray systems with non-power conductors, see the bonding and grounding guidance in Section 3.8.3.1.

Note: Power and non-power cables should be separated with a fixed barrier.

Table 3-4—Metal Area Requirements for Cable Tray Systems Used as Equipment Grounding Conductors (NEC Table 392.60(B))

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*			
	Steel Cable Trays		Aluminum Cable Trays	
	mm ²	in ²	mm ²	in ²
60	129	0.20	129	0.20
100	258	0.40	129	0.20
200	451.5	0.70	129	0.20
400	645	1.00	258	0.40
600	967.5	1.50**	258	0.40
1000	--	--	387	0.60
1200	--	--	645	1.00
1600	--	--	967.5	1.50
2000	--	--	1290	2.00**
* Minimum cross-sectional area of metal (as adapted from NEC Table 392.60(B)): a. both side rails for ladder or trough cable tray systems; or b. in single-rail or channel cable tray systems, or cable tray systems of one-piece construction; or c. longitudinal wires for wire mesh cable tray systems. ** NEC Table 392.60(B) states: "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."				

Note: See Section 4.7.3.1 to select wire-type EGC.

Table 3-5—Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment (NEC Table 250.122)

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Wire Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14 AWG	12 AWG
20	12	10
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 kcmil
1600	4/0	350
2000	250 kcmil	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1200
6000	800	1200

* See installation restrictions in NEC Article 250.

3.8.4 How to Install Bonding Jumpers

For examples, see Figure 3-105. Bonding jumper types include insulated, bare, braided, or laminated.

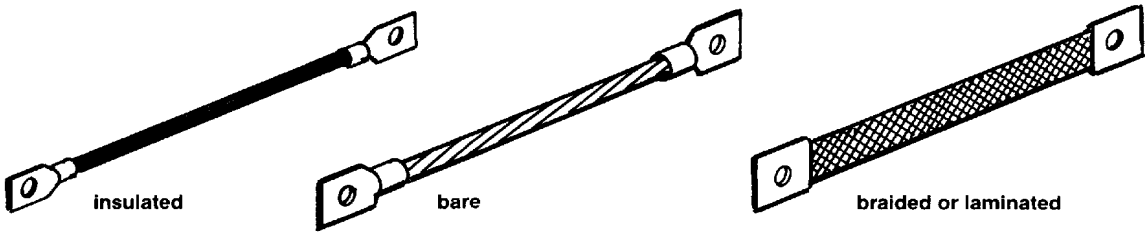


Figure 3-105—Bonding Jumper Examples

Drill holes in each side rail 50 mm (2 in.) from each end of the splice plate so the bonding jumper spans the discontinuity. Do not use splice plate bolt locations to connect the bonding jumper to the cable tray.

Place the screw head on the inside of the cable tray. Put the bonding jumper on the outside of the cable tray, add a metal flat washer and metal locknut, then tighten.

3.9 Bonding to The Metal Frame of the Building and Earth

Metal cable trays are permitted to be bonded to the metal frame of the building and earth for signal grounding (“noise” prevention). This may be desirable if the cable tray system is not inherently bonded (connected) to the metal frame of the building and earth through metal support systems.

4 Installation of Cable

The NEMA 5CT Cable Tray Section acknowledges input provided by NEMA wire and cable manufacturers to Section 4.

4.1 General

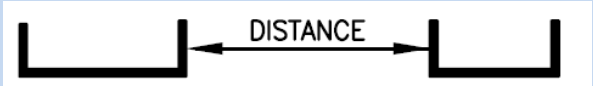
This section offers general guidelines on installing cable in a cable tray. This information is not intended to replace the recommendations of the cable manufacturer. The manufacturer of the product is the best source for information on the product, its use, and installation practices.

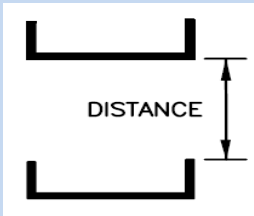
4.2 Cable and Cable Tray Spacing

Both cables and cable trays need to be properly spaced (see Table 4-2) to minimize issues with electromagnetic interference (EMI) and to allow for a safe workspace for cable maintenance. General guidelines for quantity and spacing of cable trays are as follows:

- a. Medium-voltage (MV) (2001 V-35000 V ac, 2001 V- 2500 V dc) cable(s) should not be permitted to be installed with cables of other voltages and should be installed in a tray designated for medium voltage only.
- b. Low-voltage (LV) (2000 V or less) cables installed in a cable tray should be separated as defined in Table 4-2.
- c. When multiple cable tray tiers are installed (or stacked), the higher-voltage cable tray **should be installed above the lower-voltage cable tray**.
- d. Cables operating over 1,000 V should be separated from the cables operating at 1,000 V or less by a solid fixed barrier of a material compatible with the cable tray.
- e. Communication signal and power cables with voltage 50 V or less are allowed in the same cable tray.
- f. Vertical or horizontal cable tray separation is $\frac{1}{2}$ of cable tray width with a minimum spacing of 12 in., with the exception of control cable and MV or power cables greater than 20A; those require a minimum 24-in. spacing.
- g. Redundant circuits should utilize a completely different tray and route.

Table 4-2—Horizontal and Vertical Cable Tray Separation

HORIZONTAL		High-voltage CT	Low-voltage CT	Instrument and Communication
				
High-voltage CT		0	300mm	600mm
Low-voltage CT		300mm	0	300mm
Instrument and Communication		600mm	300mm	0

VERTICAL	High-voltage CT	Low-voltage CT	Instrument and Communication
			
High-voltage CT	300mm	300mm	600mm
Low-voltage CT	300mm	300mm	300mm
Instrument and Communication	600mm	300mm	300mm

4.3 Cable Tray Preparation

Before installing cable in the cable tray, examine cable paths to ensure that all areas are free of debris that may interfere with cable installation. A cable tray should never be used as a walkway.

4.4 Cable Pulling Considerations

Most cable installations require the use of cable pulling tools (see Figure 4-1).

- a. On horizontal straight runs, cables generally ride on rollers mounted in or on cable trays (see Figure 4-4). These rollers should be properly spaced, depending on the size and weight of the cable, to prevent the cable from sagging and dragging in the cable tray during the pull. Contact the cable manufacturer for information regarding proper roller spacing.
- b. On horizontal bends and vertical pulls, cables are generally run through pulleys or sheaves to maintain a minimum bending radius (see Figure 4-5 and Figure 4-6). Pulleys and sheaves of sufficient diameter prevent pinching the cable between the pulley flanges. Maintain each cable's minimum bending radius 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.
- c. Due to the length of some cable pulls and the cable weight, a large amount 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 cable tray due to the force that can be applied during pulling. Do not pull down on the horizontal rollers; they are not designed for this purpose, and damage to the cable or cable tray could result.

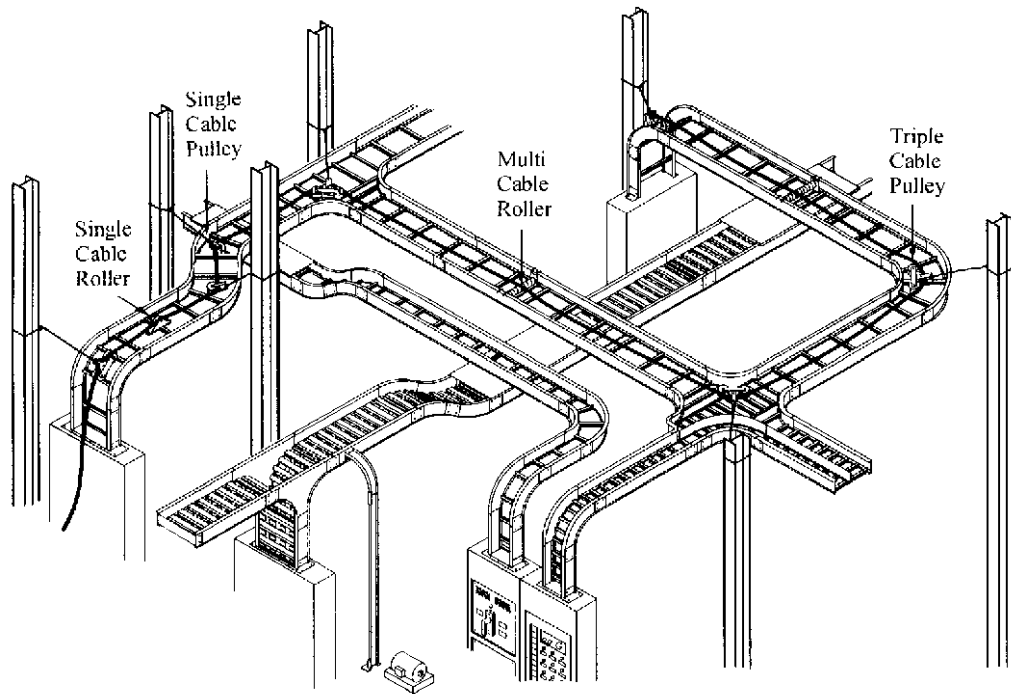


Figure 4-1—Cable Installation

4.5 Pulling the Cable

Larger cables usually require a basket grip and/or pulling eye to be attached to the leading end of the cable's bare 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 (see Figure 4-2 and Figure 4-3). Where pulling attachments are used on the conductors, cover them with rubber-like or plastic tapes to prevent scoring of the cable trays and installation sheaves during a conductor pull. Generally, the reel will be placed on reel jacks with an axle of sufficient size and strength to allow the reel to turn freely with minimum friction. Since cables have pulling tension restrictions, a dynamometer may be installed at the pulling end and the readings recorded with every pull to ensure that the cable's maximum pulling tension is not exceeded.

Communications should be established between the pulling end of the run and the reel end of the run. During the pull, the cable should be pulled at a constant speed. 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, to watch and 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 and resealing of cable ends and connections. Once the cable is installed, remove the cable from the pulling devices and lay it in the cable tray. Do not allow cables to drop in the cable tray; this may damage the cable and/or the cable tray. If cable connections are not to be made immediately, the pulling eye or basket grip should be removed and all cable ends resealed to prevent moisture from entering the cable (see Figure 4-4 through 4-6).

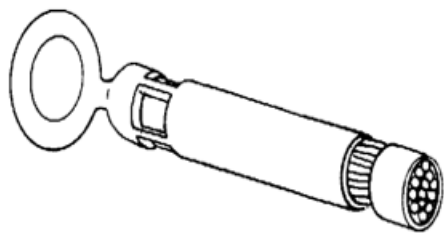


Figure 4-2—Pulling Eye

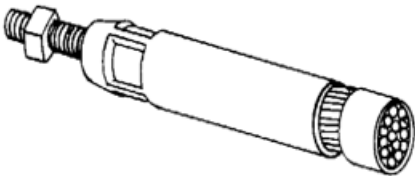
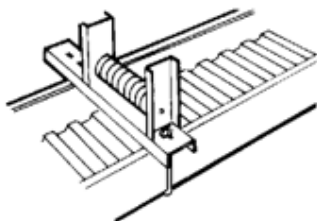
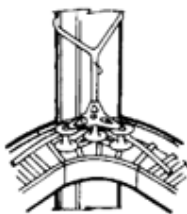


Figure 4-3—Pulling Bolt



**Figure 4-4—Straight Roller
(Top Mounted)**



**Figure 4-5—Triple
Pulley Guide**

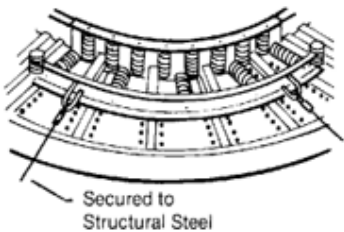
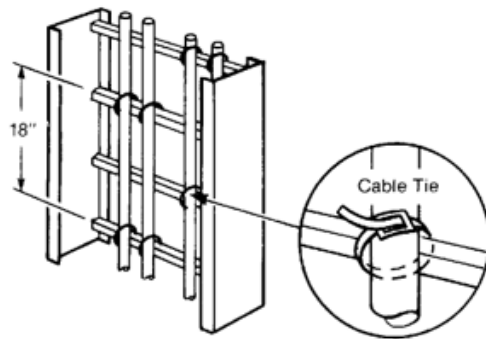


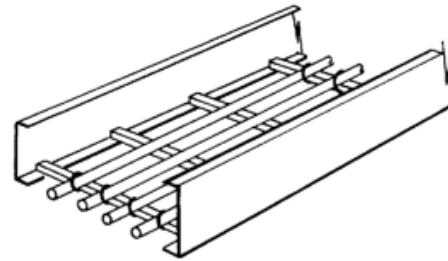
Figure 4-6—90° Roller

4.6 Fastening Cables

- a. Cables may be fastened to the cable tray by means of cable clamps, cable cleats, or cable ties (see Figure 4-7 and Figure 4-8). Generally, cables are fastened every 450 mm (18 in.) on vertical runs to maintain spacing and ensure that the cable is confined within the cable fill area. When using cable clamps, the clamps should be sized correctly and tightened only 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 issues requiring special consideration. In many cases, the weight per meter (foot) of the cable multiplied by the number of meters (feet) in the vertical drop exceeds the load-carrying capacity of the cable tray component. The one or two rungs supporting this weight are likely to be damaged, and the vertical load could exceed the allowable cable tension. The cable weight should be supported in such a manner as 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.
- c. Offshore installations may require stainless steel cable ties or stainless cable banding, depending on the cable positioning.



**Figure 4-7—Cable Ties—
Vertical Application**



**Figure 4-8—Cable Ties—
Horizontal Application**

4.7 Protecting Installed Cable

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

5 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 70E. If cables are to be touched or moved, they should be de-energized.

5.1 Inspection

Although cable trays are virtually maintenance free under normal conditions, inspection of cable trays is recommended as part of a facility's routine maintenance schedule for electrical equipment. Cable trays should be inspected and 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 the potential for fire hazard.

Visual checks should be made for surface corrosion and damage. These areas should be treated as stated in ASTM A780 (surface treatment).

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

5.2 Inactive or Abandoned Cables

Good cable and wire management includes removing inactive or abandoned cables from the cable tray system. This practice opens capacity in the cable tray system for future cable needs and eliminates the difficulty electricians have in trying to establish the routing of an inactive cable.

1304 **5.3 Adding Cables**

1305 When additional cables are to be added to the cable tray system, refer to NEC Article 392 or CEC Part 1
1306 (for allowable fill), as well as NEMA VE 1 and NEMA FG 1 (for allowable load). Check the adequacy of
1307 supports before installing additional loads.

1308 Follow the cable manufacturer's recommended procedures for pulling and installing cables (also see
1309 Section 4).

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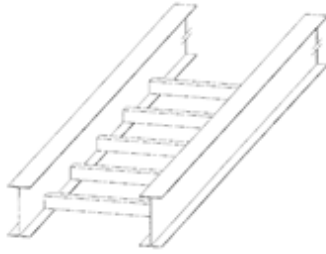
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ANNEX A Typical Cable Tray Types

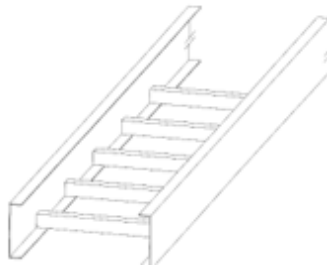
1314 Annex A provides examples of typical cable tray types.

1315 A.1 Cable Ladders

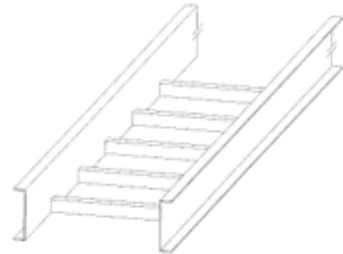
1316 For examples of cable ladders, see Figure A-1 through Figure A-3.



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1318 **Figure A-1—I-Beam**



**Figure A-2—C-Channel
Flange In**



**Figure A-3—C-Channel
Flange Out**

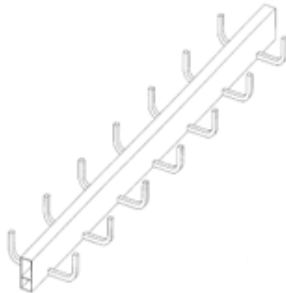
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1320 A.2 Single-Rail Cable Trays

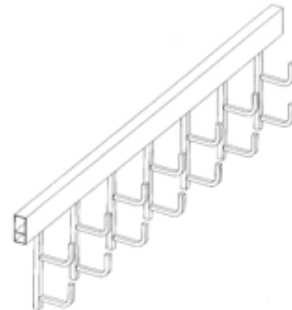
1321 For examples of single-rail cable trays, see Figure A-4 through Figure A-6.



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1323 **Figure A-4—Center Rail**
1324 **Cable Tray**



**Figure A-5—Single-Tier
Wall Mount**



**Figure A-6—Multi-Tier
Wall Mount**

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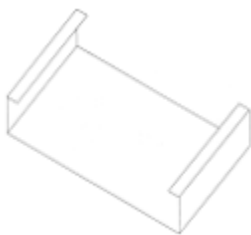
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1325 A.3 Solid-bottom Cable Trays

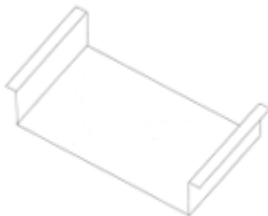
1326 For examples of solid-bottom cable trays, see Figure A-7 through Figure A-10.

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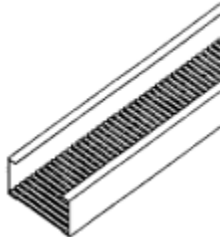
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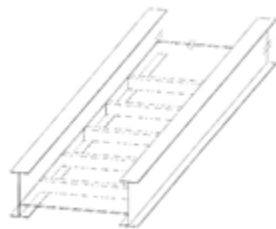
**Figure A-7—Pan
Flange In**



**Figure A-8—Pan
Flange Out**



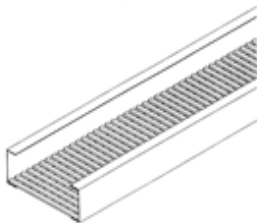
**Figure A-9—
Corrugated
Bottom**



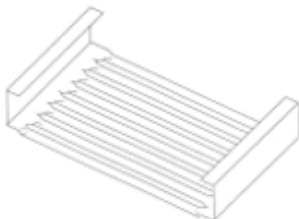
**Figure A-10—Solid Sheet
on Top of Ladder Rung**

A.4 Trough (Ventilated Cable Trays)

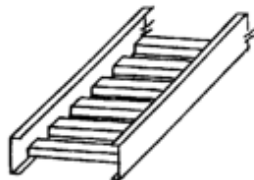
For examples of trough (ventilated cable trays), see Figure A-11 through Figure A-13.



**Figure A-11—Corrugated
Bottom with Holes**



**Figure A-12—Pan with
Louvers**



**Figure A-13—Tray with Close
Rung Spacing**

A.5 Wire Mesh Cable Tray

For an example of a wire mesh cable tray, see Figure A-14.

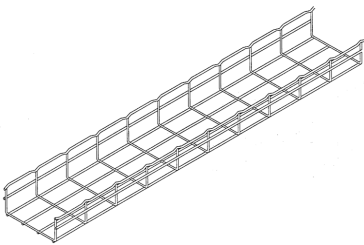


Figure A-14—Wire Mesh

A.6 Channel Cable Trays

For examples of channel cable trays, see Figure A-15 and Figure A-16.

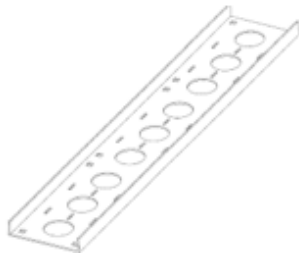


Figure A-15—Ventilated Bottom

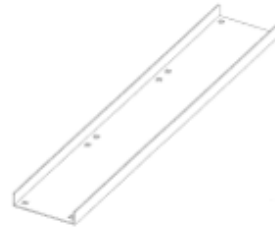


Figure A-16—Solid Bottom

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