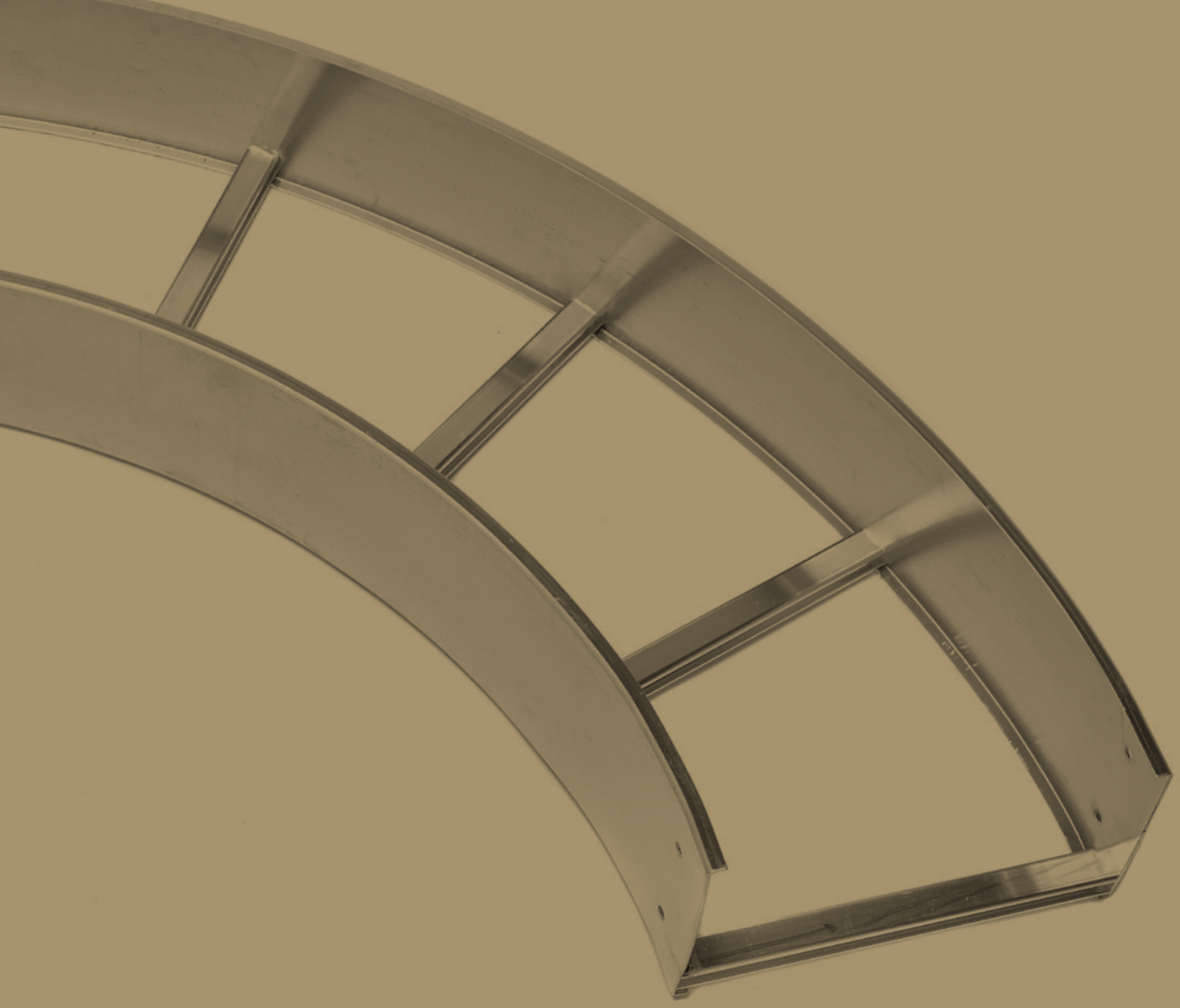

INSTALLATION GUIDE

UNITRAY
SYSTEMS INC

UNITRAY IS 100% CANADIAN OWNED AND OPERATED. WE WORK TO ACHIEVE THE QUALITY AND RELIABILITY THAT OUR INDUSTRY DEMANDS

We have more than a decade's worth of experience making and designing quality cable tray and cable management systems. Our knowledgeable production team works closely with each customer to provide quality solutions based on your schedule and budget.

We want each and every experience with our company to be a good one. Through ongoing quality assurance analysis and evaluation of our manufacturing techniques, we strive to exceed the expectations of our customers. We act with honesty, integrity and effectiveness to achieve the quality, durability, safety and reliability that our industry demands.

UNITRAY
SYSTEMS INC

C US

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SECTION A: INTRODUCTION

To ensure that the complete ladder tray wiring system performs as designed, it is important that it is properly installed. Personal injury as well as property damage will result if proper installation and maintenance procedures are not adhered to. Qualified field personnel working to a pre-determined layout plan will save considerable installation time. Per the Canadian Electrical Code (CEC) a qualified person is one who is familiar with the construction of the apparatus and the hazards involved.

The system designer (engineer) who has access to the local building codes, the building design, equipment specification and location, and the clearances required by other subtrades is the person best suited in designing the layout and supporting structures. It is the designer who has the technical information critical in designing and routing a satisfactory support structure. Due to the ease in field altering today's ladder tray product, there is a tendency to leave the routing up to the electricians on site. On a project of considerable scope there are large quantities of strut, threaded rod, clips, connectors, ladder tray, fittings as well as hardware, all intended for specific functions and locations. Field personnel must be free to do their disciplines of electrical constructions, testing, energizing, grounding and locking out of circuitry. All this must be done in accordance with the Canadian Electric Code (CEC), Occupational Health and Safety procedures, as well as local and customer building regulations.

SECTION B: RECEIVING AND UNLOADING

Due to the increasing complexity and inherent technical nature of today's electrical products, care should be taken in packing, delivering and receiving the product. Reference to detailed documentation will save considerable hours searching for components as the job progresses.

To limit damage, straight lengths should be bundled and shipped on a flat deck trailer. Straight lengths are shipped without exterior crating. Fittings and ancillary products are often boxed/palletized and shipped either on a flat deck or if a separate order via an enclosed van.

Due to the ratio of ladder tray's bulk to its weight, the freight costs for tray are higher than other metallic products. If scheduling permits, freight costs for ladder tray can be greatly reduced if shipped with other project items (e.g. strut).

Ocean going shipments should be transported via container.

When offloading tray from a flat deck trailer using an overhead crane, care should be exercised in the placement and length of the slings to prevent crushing the product (siderails).

During forklift offloading on uneven ground, one must exercise extreme caution to prevent load shifting. Only offload single bundles per lift.

When shipping straight sections by van, all loading and offloading should be done by hand. Exceptions can be made if straight sections are palletized. In no case should the tray be used as an attachment point for forklift tynes, chains or slings to withdraw the product from within the van.

Immediately after unloading, use the manufacturer's packing list to note shipping damage or shortages in order to file a freight claim. Regardless of the freight terms of payment, the manufacturer should be notified.

SECTION C: STORAGE

All tray items whether stored outside or indoors, should be placed on sufficient dunnage to enable future mechanical lifting. Trays and fittings should be stacked by their physical dimensions (width) and type. All material finishes are prone to storage stain if they are improperly stored outdoors.

If appearance is important, ladder tray should be stored indoors or covered outdoors with adequate ventilation. With the exception of Type II tray, and PVC (painted) tray, ladder tray can be stored outdoors providing the following steps are taken:

a. Store away from well travelled corridors
b. Stack loosely on adequate dunnage to prevent contact with moisture and the ground. For straight lengths; dunnage should be placed no closer than 1/4 of the tray from its ends if using 2 supporting points. For 6 meter tray that would be approximately 1.5 meters from either end. If not covered, the tray should be stacked slightly higher at one end to allow for the drainage of accumulated moisture.

SECTION D: INSTALLATION

Installation should only be attempted by site personnel well versed in provincial and federal electrical construction practices and the CEC as it relates to electrical equipment and wiring.

D.1: COMMON TOOLS FOR INSTALLATION

a. Metric tape measures
b. Ratchet and socket set (3/8" drive)
c. Four (4) foot level
d. Transit or laser level
e. Two (2) 24" squares
f. C-Clamp (2) 4"
g. Torque wrench
h. Open/closed end box wrenches
i. 3/8" drive portable drill with bits
j. Assorted screwdrivers
k. Touch up paint and cheap brushes for all tray except aluminum
l. 7-1/4" skill saw with appropriate blades e.g. Carbide tip or fine tooth (plywood) for aluminum
m. Cutting lubricant e.g. Turpentine for aluminum
n. Hand hack saw
o. Metal file (medium)
p. Scribe or other metal marking unit.
q. 7R Vise grips
r. Sawzall

LADDER TRAY IS A MECHANICAL SUPPORT SYSTEM FOR CABLES AND IS NOT TO BE USED AS A WALKWAY, LIFTING APPARATUS OR LADDER.

This article is intended only as a practical guide for installers and its intent is not to cover all the possible contingencies encountered on site.

D.2: INSTALLATION OF SUPPORT STRUCTURE

NOTE:

CAUTION MUST BE EXERCISED WHEN DRILLING INSERTS. FOR ALL-THREADED HANGERS INTO PRE-STRESSED CONCRETE APPROVAL FOR LOCATION DRILLING SHOULD BE GIVEN BY THE GENERAL CONTRACTOR. STRUCTURAL MEMBERS SHOULD NOT BE DRILLED OR CUT. THE STRUCTURAL ENGINEER SHOULD BE CONSULTED. CONTACT OUR FACTORY FOR ALTERNATIVE PRODUCT SOLUTIONS.

Elevations must be determined for either the top or bottom of the tray run. An elevation benchmark (preferably set by the general contractor) can be transferred via laser level or transit to convenient points along the length of the tray run. Once the lengths and quantities of the hangers are determined an apprentice can be set up for mass cutting and the pre-threading of hex nuts onto one end of the threaded rod. Another option is to have the factory precut the rods and horizontal supports to the required lengths. Care should be taken while cutting the rod so that the threads are not damaged. Valuable time can be lost starting nuts on rod ends cut improperly. Once a few hangers are hung at points along the tray run, a carpenter's string or baling wire strung from end to end will assist in establishing the elevations for the tray supports. Pre-threading of the nuts on the all-thread hanger rods can be speeded up by the use of a 3/8" variable speed drill and a set of vise grips. One end of the rod is inserted into the chuck of the drill. The nut is pre-threaded at the other end by hand and then the vice grips are attached to it. The drill is then used to spin the rod until the nut reaches its appropriate location.

D.2.1: TRAY SUPPORTS

Despite the system designer's attempts to provide the field personnel with a definitive layout, job conditions sometimes dictate a rerouting of the tray system. The field supervisor must be familiar with the total loads the support structure will be subjected to. He must also be aware of the placement of these supports in relation to the location of the tray connectors to prevent joining the trays in a simple beam configuration. (refer to CEC Table 42 Rule 12-2200). There are numerous methods of supporting the ladder tray system. This article will cover the common ones. Please consult our factory for situations not covered in this guide.

D.2.1.1: TRAPEZE (SWING) TYPE (REFER TO DIAGRAMS D.1.A THROUGH D.1.E)

The Trapeze or swing support is the most common type.

To Install:

i. Thread hex nut 25 mm (1") to 50 mm (2") above location of the tray bottom.
ii. Slide on square washers. The cross member comes next followed by a second set of square washers. All vertical hangers will project through the cross member. Therefore, sufficient size holes will have to be punched or drilled through the cross member. These holes should be 1/16" to 1/8" larger than the diameter of the all-thread to prevent thread damage and easy adjustment of the cross member. The length of the cross member should be sufficient to allow for the attachment of the tray clips plus some horizontal adjustment of the tray.
iii. Thread second set of hex nuts onto all-thread moving the top of the cross member up to the underside of the ladder tray.
iv. Ensure cross member is level (with bottom set of hex nuts), then move top set of nuts down until the cross member is snug and level.
v. Cross check the length of cross member to ensure tray clips and required horizontal adjustment can be accomplished.
vi. In most instances (except where tray rung or connector interferes) the tray clip (CG*-1) may be installed either inside or outside the tray.

DIAGRAM D.1.A 1/2" SPRING NUTS

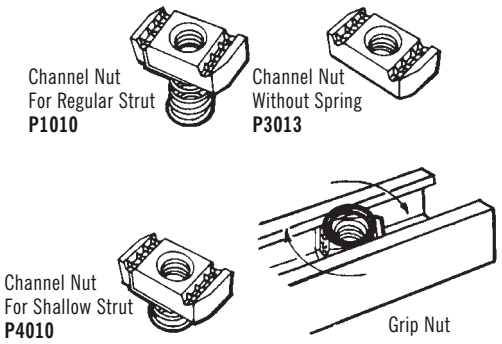


DIAGRAM D.1.B ANGLE IRON

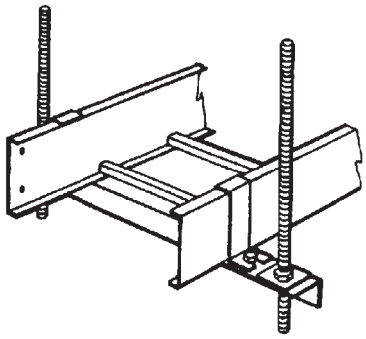


DIAGRAM D.1.C STRUT

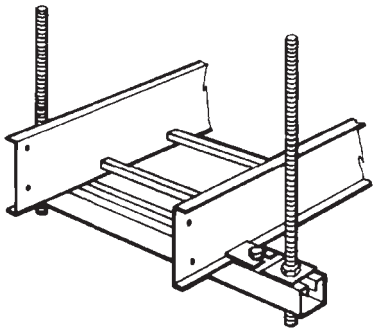


DIAGRAM D.1.D TYPICAL STRUT INSTALLATION

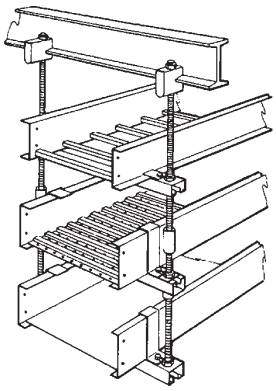


DIAGRAM D.1.E STRUT-EXPLODED VIEW 1/2" ROD

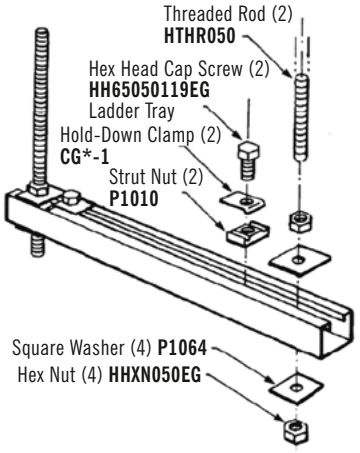
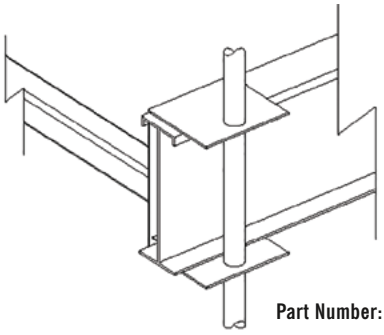


DIAGRAM D.2.A SINGLE LADDER HANGER



Part Number: SC

D.2.1.2: HANGER CLAMPS (REFER TO DIAGRAMS D.2.A AND D.2.B)

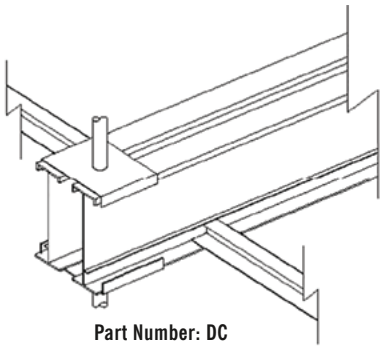
This system allows for very little horizontal adjustment of the tray once the vertical hangers are in place. It is essential that these hangers be positioned properly. Horizontal adjustment is proportionate to the length of the vertical rods. The shorter the rod, the less horizontal adjustment allowed.

If clamps being used are SC refer to diagram D.2.A.

To Install:

i. Thread upper hex nut onto all-thread 203 mm (8") above the location of the tray bottom.
ii. Position the clamps (SC) around the siderails of the ladder tray.
iii. Place one round washer on each hanger rod and then lift tray section so that the threaded rod runs through the two holes in the clamp (SC). Care must be taken to keep the round washer between the uppermost hex nut and the top of the clamp.
iv. Place a second washer onto the threaded rod followed by a second hex nut. Thread this second nut up the threaded rod until the bottom of the tray reaches the desired location.
v. Thread the upper (first) nuts down until the clamps (SC) are in location and secured. If using double ladder hanger clamps (DC) to support two (2) adjacent trays refer to Diagram D.2.B.

DIAGRAM D.2.B DOUBLE LADDER HANGER



Part Number: DC

To Install:

i. Thread upper hex nut onto all-thread 50 mm (2") above the top rail of existing tray.
ii. Slide round washer followed by one half of the DC clamp. These can be positioned over the top of the existing tray's siderail on one side.
iii. Then lift the tray section until it is adjacent to existing tray.
iv. Thread a second set of hex nuts preceded by a flat washer and the remaining section of the DC clamp up the all-thread until the desired tray elevation is reached.
v. Thread the first set of hex nuts downward until the clamps (DC) are in location and secured.

D.2.1.3: SINGLE ROD HANGER SUPPORT (REFER TO DIAGRAMS D.3.A AND D.3.B)

Center hung tray supports allow for quicker and easier cable installation by allowing cables to be deposited into tray systems from each side. There is a maximum load capacity per hanger of 318 kg (700 lbs) to 340 kg (750 lbs) with a maximum support spacing of 3.6 m. Up to 340 kg loading capability this system reduces the cost of the support system substantially. There is an overall reduction in hardware, all-thread, and field labor required in the fabrication of supports and installation. Caution must be exercised in loading the cable. Each side must be symmetrically loaded with equal cable weight on either side of the center support. This system is limited to tray width of 600 mm (24").

To Install:

i. Thread rod onto all-thread up to 203 mm (8") above bottom elevation of tray.
ii. Slide washer followed by 1⁄2" x 6" tube and another washer onto all-thread.
iii. The tray must be lifted up so that the all-thread passes through its center.
iv. Slide horizontal support onto all-thread to the underside of the tray (held at approximate elevation).
v. Place another washer on the all-thread.
vi. Thread a second nut up the all-thread until it reaches the cross member. Continue threading second nut until desired elevation is reached.
vii. Thread first nut down until cross support is held in place.

The tray can be affixed to the cross support in the majority of cases either to the inside or outside of tray. The placement of the vertical hanger is critical. They must be as close to the center grid line of the tray run as possible.

DIAGRAM D.3.A CENTER HANGER SUPPORT

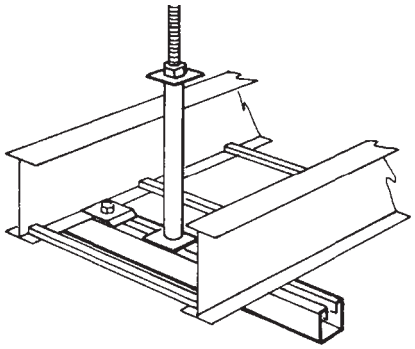
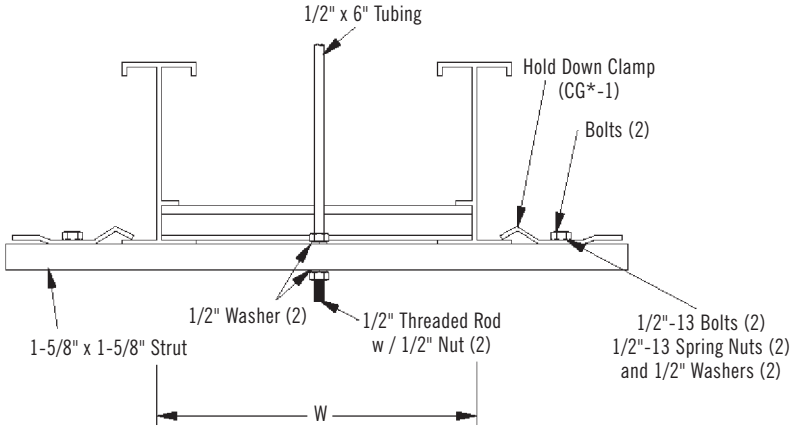


DIAGRAM D.3.B CENTER HANGER SUPPORT



D.2.1.4: SINGLE OR DOUBLE CHANNEL HANGERS (REFER TO DIAGRAMS D.4.A AND D.4.B)

These hanger supports are used for the support of 76 mm (3"), 106 mm (4") and 150 mm (6") communication channel used to carry cable, hydraulic hose and tubing. Communication channel hangers are to be used with 12 mm (1⁄2") all-thread.

DIAGRAM D.4.A SINGLE CHANNEL HANGER

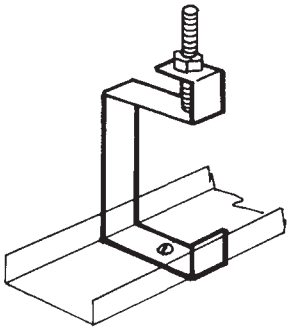
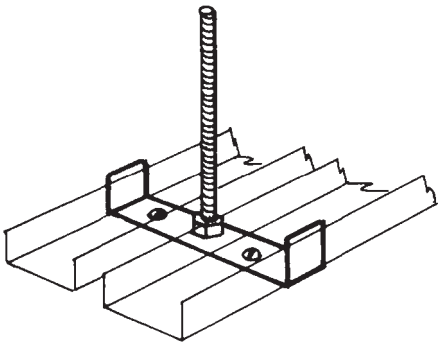


DIAGRAM D.4.B DOUBLE CHANNEL HANGER



To Install:

i. Thread nut onto all-thread 203 mm (8") above desired height (for single only)
ii. Place flat washer followed by hanger on all-thread
iii. Thread second nut on rod until bottom of hanger is at required height
iv. Install channels on hanger and secure in place.

D.2.2: WALL AND CANTILEVER SUPPORTS (SEE DIAGRAMS D.5.A THROUGH D.5.D)

These supports may be attached to the following structural materials: poured-in-place concrete, precast concrete, brick or concrete and structural steel. For concrete and concrete related structures use masonry expansion bolts. A minimum of two (2) bolts must be used. Please consult the manufacturer's data for both pullout and shear loads for masonry bolts. The masonry structure strength must also be verified. We recommend the use of Excalibur screw bolts for all substrates. For attachment to structural steel use beam clamps, bolting or welding. Avoid drilling or welding to light structural members as it may impair the capacity of the member. When welding is the only option; it must be done by a qualified welder after receiving explicit approval from the structural engineer responsible for that element.

Position trays on brackets as close to the attachment point as possible to minimize the bending moment.

The lengths of the bracket shown in diagram D.5.A is limited to 610 mm (24") and therefore, tray width should not exceed 450 mm (18"). In Diagram D.5.B the maximum length of the bracket is 559 mm (22") and maximum tray width is 300 mm (12"). In diagram D.5.C and D.5.D maximum bracket length is 900 mm (36") and maximum tray width is 750 mm (30").

DIAGRAM D.5.A SINGLE STRUT CANTILEVER BRACKET

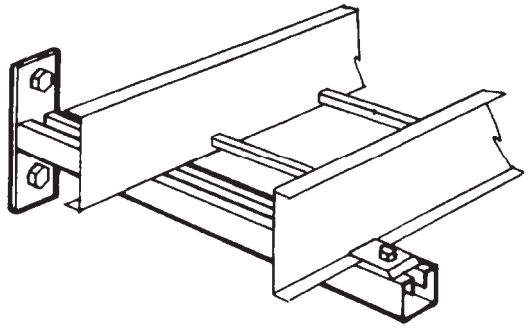


DIAGRAM D.5.B WALL SUPPORT CANTILEVER BRACKET

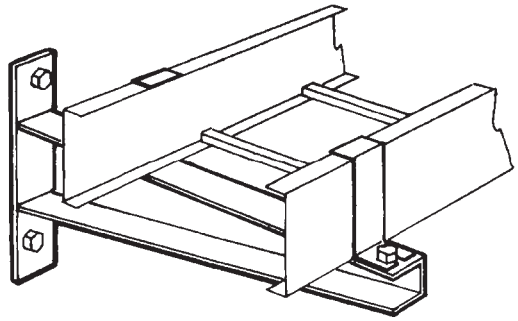


DIAGRAM D.5.C GUSSET CANTILEVER BRACKET

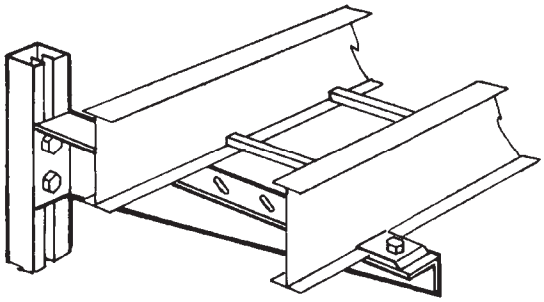
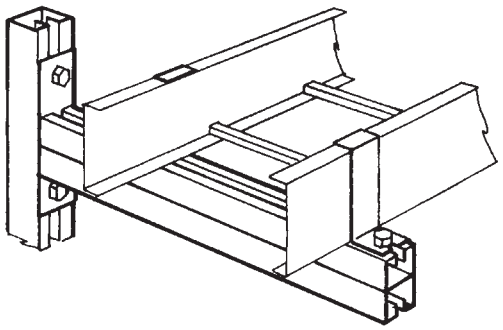


DIAGRAM D.5.D DOUBLE STRUT CANTILEVER BRACKET



D.2.3: ROOF AND FLOOR INSTALLATIONS

Ladder tray should be mounted far enough off the floor or roof to allow the cables to exit through the bottom of the tray. If strut is used as a cross support, mount the strut directly to the roof or floor. Fasten the tray to the strut using hold down clamps (CGA-*).

D.2.4: VERTICAL SUPPORT INSTALLATIONS (DIAGRAMS D.6.A THROUGH D.6.C)

The installations of supports for these applications are covered in the preceding documentation. However, due to the inherent complexity of this install, the issue of safety cannot be overemphasized. This is not an application left to the inexperienced electrician.

The securing of cable to the tray run must be accomplished through the use of “P” clamps. Plastic tie wraps are not permissible.

Pre-planning at this stage may address the installation of temporary bracing (if required) during the installation of the cable. This bracing will prevent unbalanced loading from exceeding design-bending moments. These temporary braces might also serve as pickup/fastening points for the placement of cable rollers and pulleys.

DIAGRAM D.6.A VERTICAL THREADED ROD SUPPORT

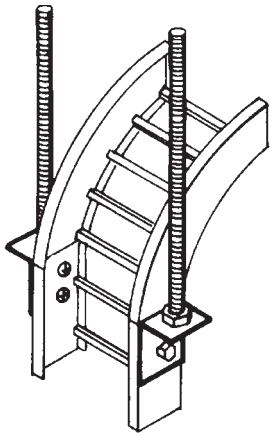


DIAGRAM D.6.B VERTICAL GUSSET CANTILEVER SUPPORT

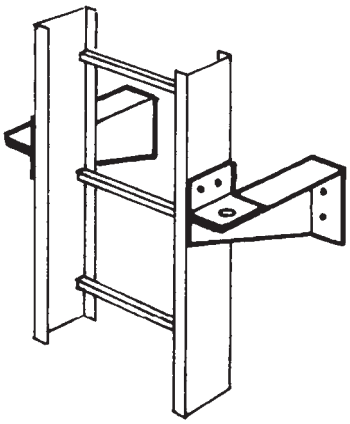
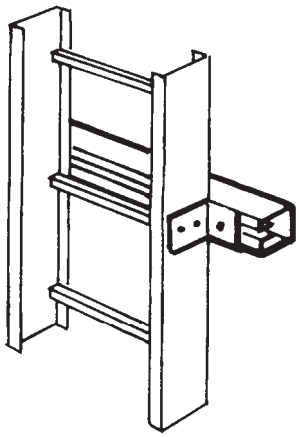


DIAGRAM D.6.C VERTICAL STRUT SUPPORT

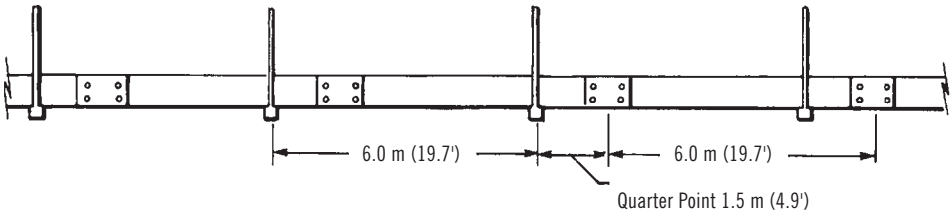


D.3: STRAIGHT LENGTH INSTALLATION (PLEASE REFERENCE CEC TABLE 42, RULE 12-2200)

D.3.1: PLACEMENT OF STRAIGHT LENGTHS (DIAGRAMS D.7.A THROUGH D.7.C)

Whenever it is feasible, designers should pre-specify the location of the connectors. This will avoid the creation of simple beam configurations, minimizing the structural repercussions of improperly located connecting points.

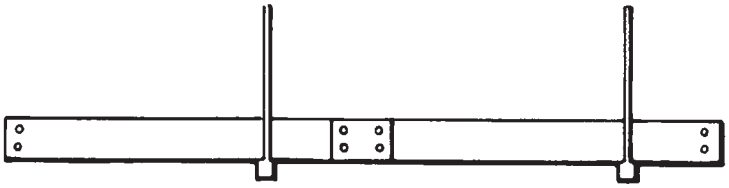
DIAGRAM D.7.A LADDER TRAY SUPPORT LOCATIONS



Once the supports are in place, installation of the ladder tray may begin at any location that is convenient. To maximize the rigidity of the ladder tray, the section should be laid out so that the splice locations are between the quarter point of the tray [1.5 meters (4.8') for a 6 meter section] and the location of the support (Diagram D.7.A). This pre-layout is especially important if the support spacing is not equal. On the other hand, if installing 6 meter tray lengths on support spacing of 6 meters, the connector plates will be in the same position (Diagram D.7.A) throughout the tray run. If the span between the tray supports is less than the length of the straight section (Diagram D.7.B), place the tray across both supports so that the ends are cantilevered. If the support span is the same as the length of tray, fasten two sections together (Diagram D.7.C). **The support span should not exceed the length of one section of tray!** There should not be more than one splice connection between two (2) supports. Do not locate tray connectors over supports or at the midpoint. Position the next straight length across the next support and connect it to the previous one. The connecting plates and bolt ends (nuts) must be on the outside of the tray. (Diagram D.8) Tighten the rib-shanked bolts to draw bolt head flush with the inside of the siderail (20-27 ft/lbs).

DIAGRAM D.7.B LADDER TRAY INSTALLATION

DIAGRAM D.7.C LADDER TRAY INSTALLATION



If it is unavoidable to place the connector over a support, an oversupport connector bracket must be used in place of the regular connector. This will help prevent structural repercussions of improperly located connecting points (Diagram D.7.D).

DIAGRAM D.7.D LADDER TRAY INSTALLATION

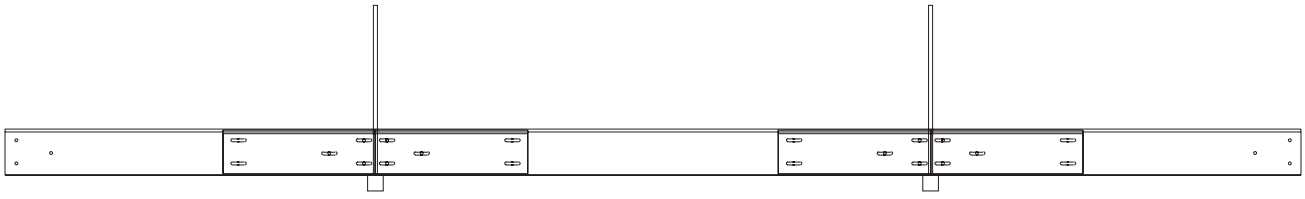
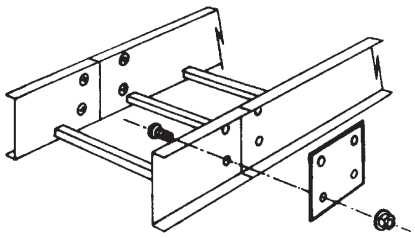


DIAGRAM D.8 UNIVERSAL CONNECTOR PLATE ATTACHMENT



D.3.2: EXPANSION CONNECTORS

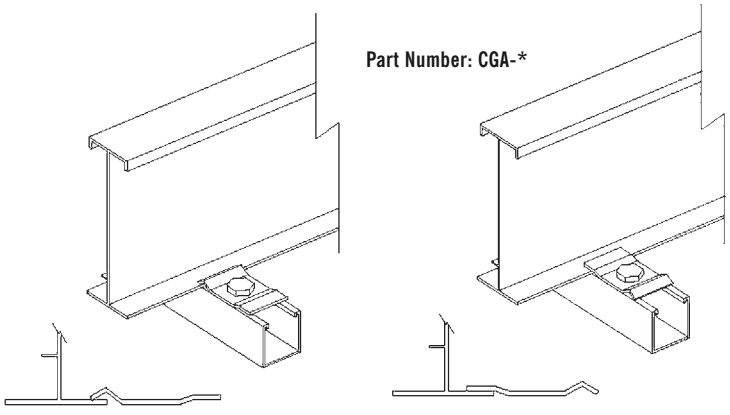
When installing ladder tray it is important to consider the amount of thermal movement of the system. This expansion and contraction is quite pronounced when installed outdoors especially in northern climates. Steel and aluminum have different coefficients of linear expansion. The number of expansion connectors (EC) is determined by: 1. temperature differential and 2. the length of the straight run of ladder tray (Diagram D.9).

DIAGRAM D.9

MAXIMUM SPACING BETWEEN EXPANSION JOINTS THAT PROVIDE FOR 25 mm OF MOVEMENT					
Temperature Differential		Steel		Aluminum	
Celsius	Fahrenheit	Meter	(FT)	Meter	(FT)
14	(25)	156	(512)	79	(260)
28	(50)	78	(256)	40	(131)
42	(75)	52	(171)	27	(89)
56	(100)	39	(128)	20	(66)
70	(125)	31	(102)	16	(52)
83	(150)	26	(85)	13	(43)
97	(175)	22	(72)	11	(36)

At the midpoint between two expansion joints the tray should be secured (no longitudinal movement). At all other support locations, the tray is secured to the supports using the expansion guide portion of our part number CGA-* (Diagrams D.10.A and D.10.B).

DIAGRAM D.10.A HOLD DOWN CLAMP/EXPANSION GUIDE



Each sold separately. Dual purpose.

DIAGRAM D.10.B

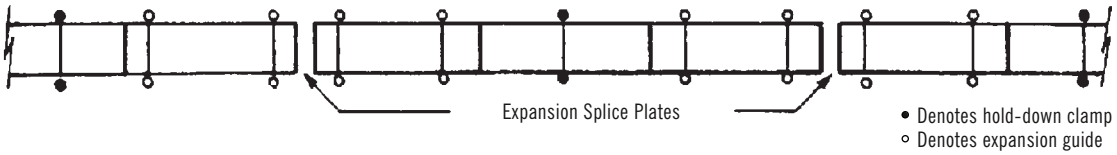
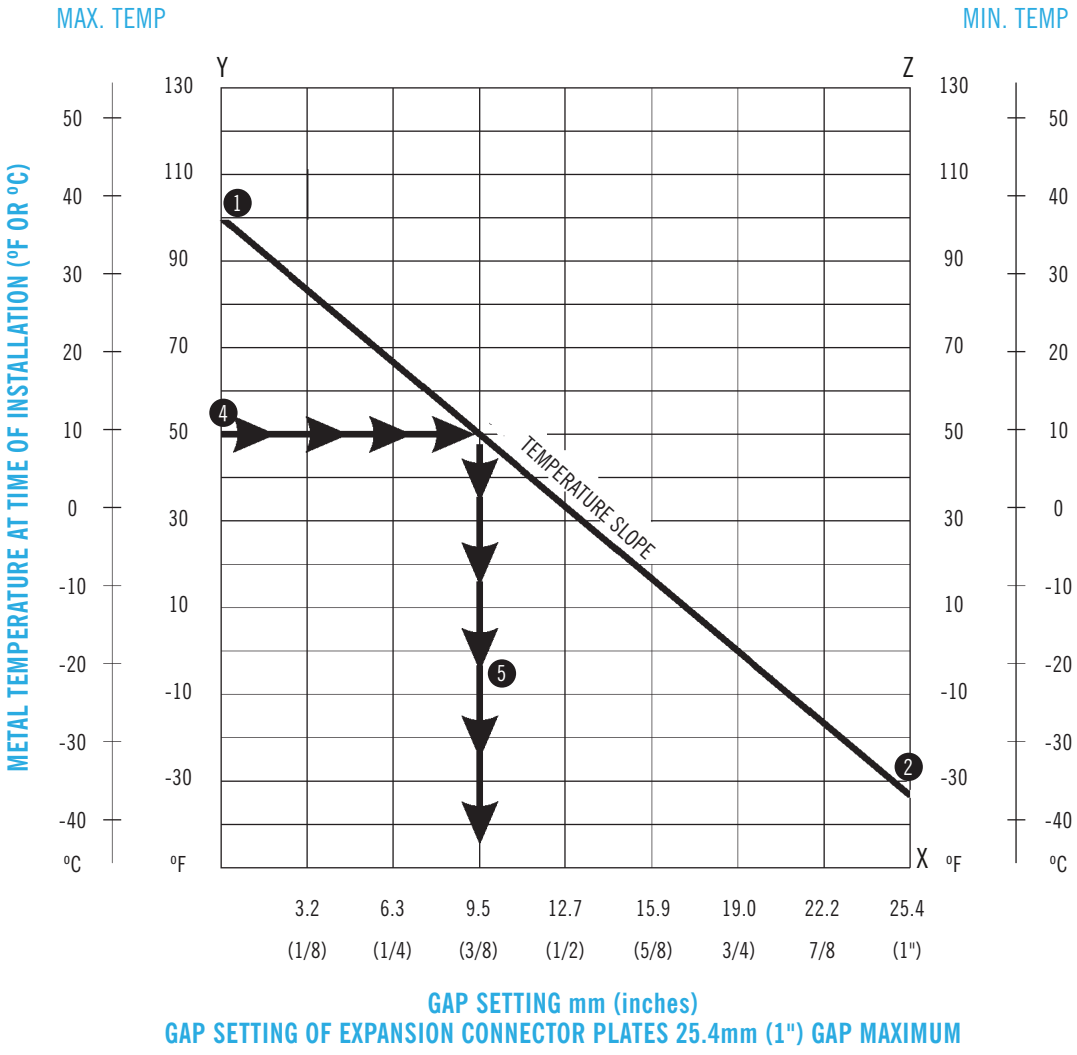


DIAGRAM D.10.C



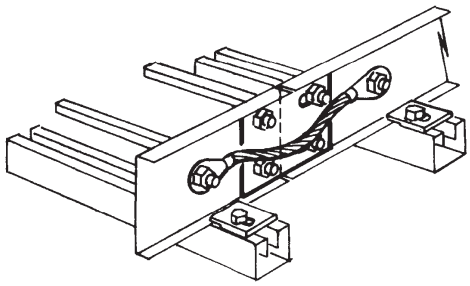
In order for the expansion connector to function properly, it is necessary to set the expansion gap accurately. Please refer to Diagram D.10.C.

PROCEDURE

Step 1: On the Y-axis mark the highest expected metal temperature 1.
Step 2: On the Z-axis mark the lowest expected metal temperature 2.
Step 3: Draw a straight line connecting 1 to 2.
Step 4: On the Y-axis find the temperature at time of install. Draw a horizontal line from that point connecting line 1 to 2.
Step 5: From the intersection point draw a straight line down to the bottom axis X.
Step 6: That point will give you the required gap setting at the time of installation.

When installing the hardware on the expansion connector, tighten the bolt (20-27ft/lbs). The underside of the bolt head must be flush with the inside of the siderail. Then back off the nut a 1/2 turn on the side of the connector that you require to expand.

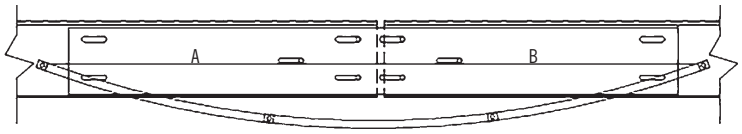
DIAGRAM D.10.D REGULAR EXPANSION CONNECTION

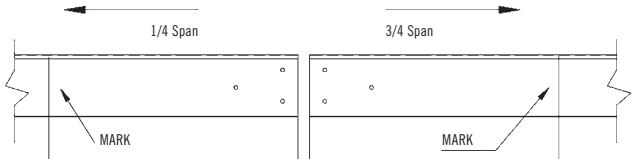
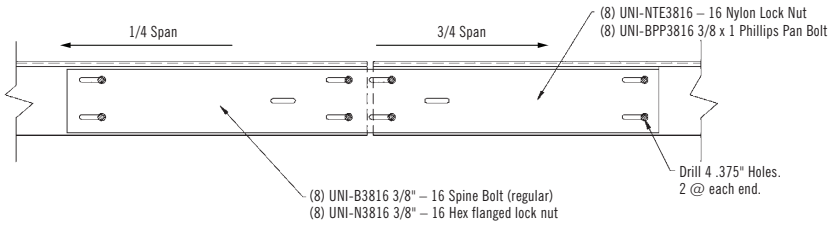
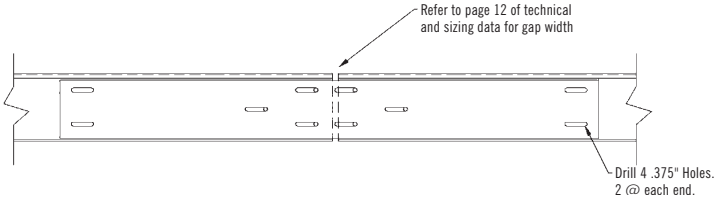
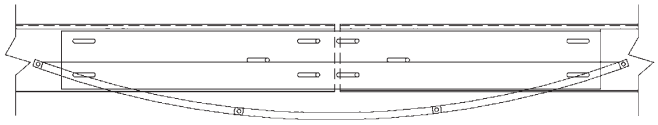


To maintain electrical continuity all expansion connectors require a bonding jumper. The ends of the jumper must be a minimum distance of 50 mm (2") from the edge of the connector plate. It must have sufficient length to allow for anticipated maximum expansion. (Diagram D.10.D). As per NEMA, there must be a support located no more than 610 mm (24") from each side of the regular expansion connector.

To reduce supports required when installing expansion connectors, use the OSB-ECA* parts instead.

D.10.E OVER SUPPORT EXPANSION CONNECTION



Step 1: Prepare OSB expansion plate and tray.	
Step 2: Install splice plate and drill holes	
Step 3: Install hardward as shown.	
Step 4: - Torque side A to 20-27 ft/lbs - Set gap - Torque side B to 20-27 ft/lbs then back off 1/2 turn	
Step 5: Install Unitray bonding jumper as required.	

D.3.3: VERTICAL CONNECTORS (SEE DIAGRAMS D.11.A AND D.11.B)

For vertical directional changes that are minor and do not require a radius fitting, use vertical connectors (VC). Position supports within 610 mm (24") of each end of connectors. As with expansion connections, bonding jumpers must be used to maintain electrical continuity.

i. Position connector halves to adjust for material thickness and fasten using 3/8" nut and bolt.
ii. Attach to existing ladder tray sections which will establish required angle.
iii. Field drill 3/8" hole (Diagram D.11.A).
iv. Insert and tighten all hardware.

DIAGRAM D.11.A TWO BOLT VERTICAL CONNECTORS

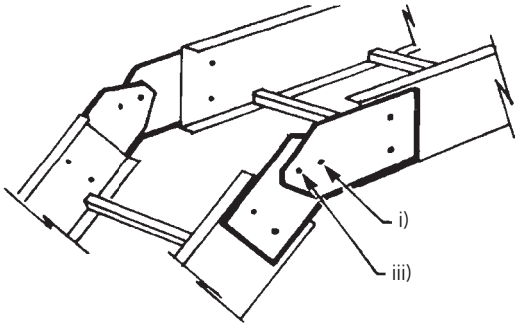
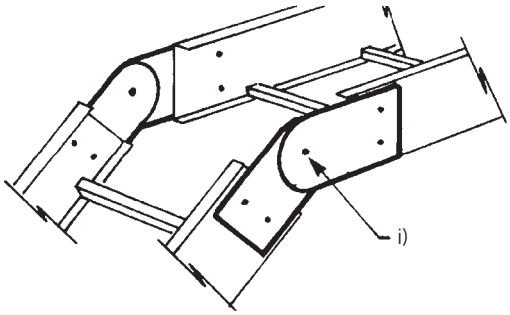


DIAGRAM D.11.B SINGLE BOLT VERTICAL CONNECTOR

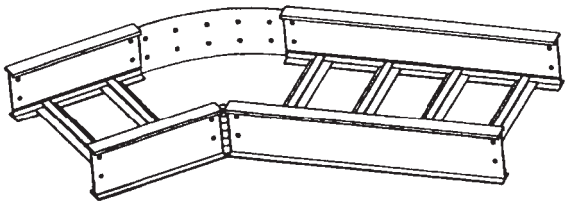


D.3.4: HORIZONTAL ADJUSTABLE ELBOW (DIAGRAM D.12)

For horizontal directional changes that are minor and do not require a radius fitting, use a horizontal adjustable elbow. Supports should be positioned within 610 mm (24") of each end of the fitting.

i. Connect inside section (with hinge) and position existing tray sections to establish angle.
ii. Position outside connector locating plate at the midpoint.
iii. Trim excess material (if required) from the ends of the outside connecting plate. Install and tighten all hardware. As with expansion and vertical connectors, bonding jumpers may be required to maintain electrical continuity.

DIAGRAM D.12 HORIZONTAL ADJUSTABLE ELBOW



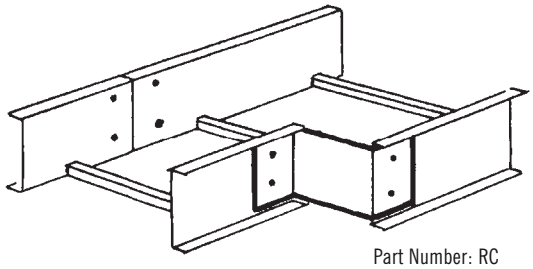
Part Number: AH

D.3.5: REDUCING CONNECTORS (DIAGRAM D.13)

When there is an immediate change in tray width use reducing connectors (RC). Supports should be located within 610 mm (24") of each side of the reducing splice plates.

i. To form an offset reduction, use a reducing connector.
ii. To form a straight reduction, use a pair (2) of reducing connectors. D.3.5: REDUCING CONNECTORS (DIAGRAM D.13)

DIAGRAM D.13 OFFSET REDUCING CONNECTORS

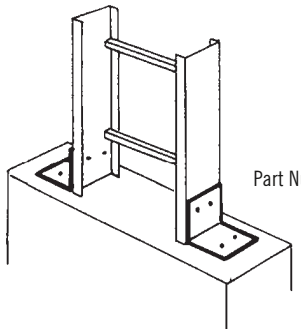


Part Number: RC

D.3.6: BOX-TO-TRAY CONNECTORS (DIAGRAM D.14)

Box-to-tray connectors (BT) are used to terminate (attach) the end of a tray system to a distribution box, control center or to a structural element.

DIAGRAM D.14 TRAY-TO-BOX/FLOOR SPLICE PLATES

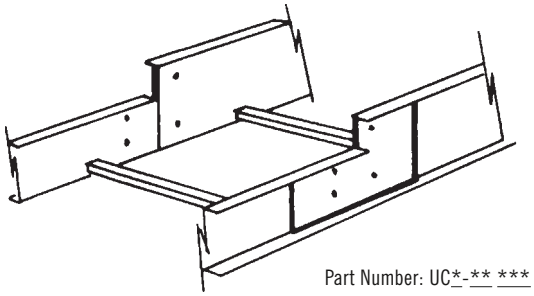


Part Number: BT

D.3.7: ADAPTER CONNECTORS (DIAGRAM D.15)

When connecting ladder trays of different siderail heights or brands, use Adapter Connectors.

DIAGRAM D.15 ADAPTER CONNECTORS

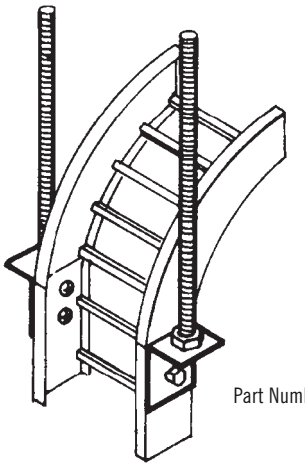


Part Number: UC*-** ***

D.3.8: VERTICAL SUPPORT CONNECTORS (DIAGRAM D.16)

For the support of extended vertical tray runs, use Vertical Support Connectors.

DIAGRAM D.16 VERTICAL SUPPORT CONNECTORS

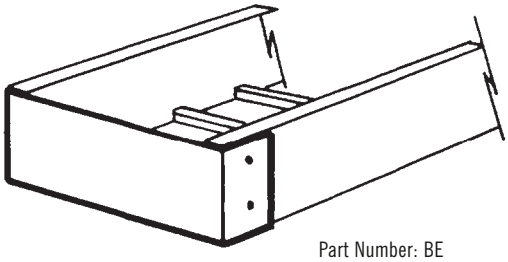


Part Number: VBA-*

D.3.9: BLIND END CONNECTORS (DIAGRAM D.17)

The ends of ladder tray shall be closed by the use of blind end closures.

DIAGRAM D.17 BLIND END CONNECTOR



Part Number: BE

D.4: FITTING INSTALLATION

NOTE: All aluminum fittings supplied by Unitray have zero tangents at each end. This tangent is the straight section at the end of the fitting to accommodate a connector plate. With some brands this may be as much as 100 mm (4"). The elimination of 203 mm (8") on each axis of a horizontal fitting saves space in a confined area.

D.4.1: SUPPORT LOCATIONS FOR FITTINGS

CSA does not publish fitting support criteria. We have previously only relied on NEMA V-2 installation recommendations. Ladder tray comes under its greatest stress all fitting locations during cable pulls. It is critical that the structural integrity of the system is not compromised during cable pullings.

Extensive testing on Unitray's standard fittings demonstrated that in addition to NEMA V-2 recommendations, standard fittings can be safely installed using any of the following installation alternatives for support locations.

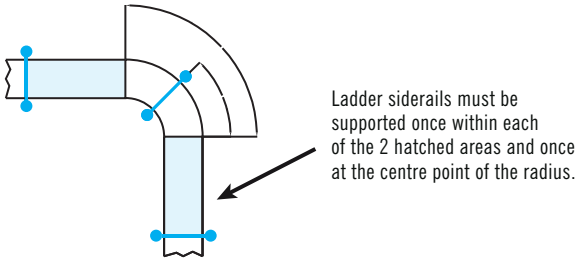
D.4.1.1 HORIZONTAL FITTING SUPPORTS

D.4.1.1.A HORIZONTAL FITTING SUPPORT – NEMA STANDARD

Supports for horizontal fittings should be located at a distance, no greater than 610 mm (24") from each end of the fitting on the attached ladder. Fitting must also be supported at the radius centre point on both sides of the fitting as per below:

i. At the midpoint (45°) of the arc for a 90° elbow.
ii. At the midpoint (30°) of the arc for a 60° elbow.
iii. At the midpoint (22.5°) of the arc for a 45° elbow, excluded are 305 mm (12") radius fittings.
iv. At the midpoint (15°) of the arc for a 30° elbow, excluded are 305 mm (12") radius fittings.

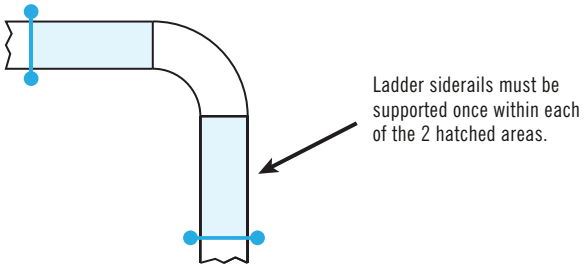
DIAGRAM D.18.A HORIZONTAL ELBOW SUPPORT – NEMA STANDARD



D.4.1.1.B HORIZONTAL FITTING SUPPORT – ELIMINATE FITTNG SUPPORT

Supports for horizontal fittings should be located at a distance, no greater than 610 mm (24") from each end of the fitting on the attached ladder. Fitting support is eliminated.

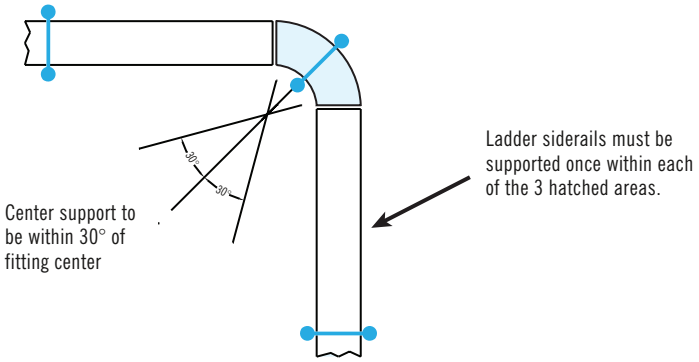
DIAGRAM D.18.B HORIZONTAL ELBOW SUPPORT – ELIMINATE FITTING SUPPORT



D.4.1.1.C HORIZONTAL FITTNG SUPPORT – EXTEND DISTANCE OF SUPPORT

Supports for horizontal fittings should be located at a distance, no greater than 3000 mm (10') max from each end of the fitting on the attached ladder. Fitting supported within 30° of radius center point on both sides.

DIAGRAM D.18.C HORIZONTAL ELBOW SUPPORT – EXTEND DISTANCE OF SUPPORT



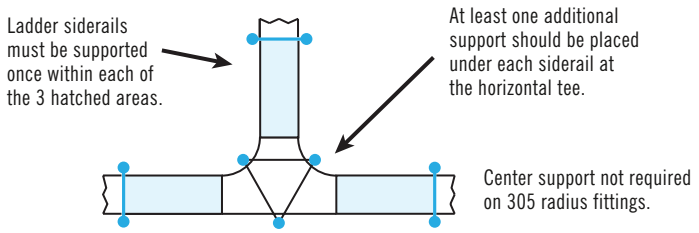
D.4.1.2 HORIZONTAL TEE SUPPORTS

D.4.1.2.A HORIZONTAL TEE SUPPORT – NEMA STANDARD

Supports for horizontal tee fittings should be located at a distance, no greater than 610 mm (24") from each end of the fitting on the attached ladder. Fitting should also be supported once on each siderail.

For 305 mm (12") radius tees, place supports no greater than 610 mm (24") from each end of the fitting on the attached ladder.

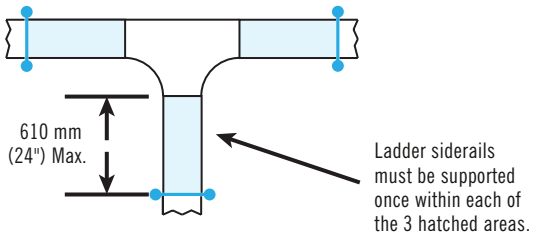
DIAGRAM D.19.A HORIZONTAL TEE SUPPORT – NEMA STANDARD



D.4.1.2.B HORIZONTAL TEE SUPPORT – ELIMINATE FITTING SUPPORT

Supports for horizontal tee fittings should be located at a distance, no greater than 610 mm (24") from each end of the fitting on the attached ladder. Fitting support eliminated.

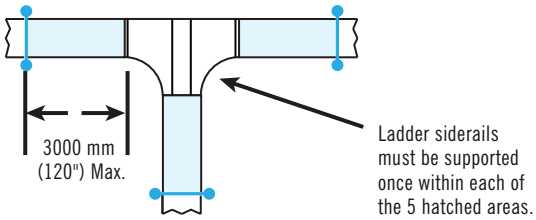
DIAGRAM D.19.B HORIZONTAL TEE SUPPORT – ELIMINATE FITTING SUPPORT



D.4.1.2.C HORIZONTAL TEE SUPPORT – EXTEND DISTANCE OF SUPPORT

Supports for horizontal tee fittings should be located at a distance, no greater than 3000 mm (10') max from each end of the fitting on the attached ladder. Fitting supported twice within defined area.

DIAGRAM D.19.C HORIZONTAL TEE SUPPORT – EXTEND DISTANCE OF SUPPORT



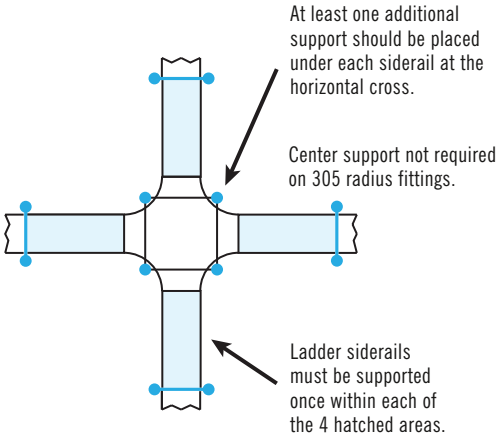
D.4.1.3 HORIZONTAL CROSS SUPPORTS

D.4.1.3.A HORIZONTAL CROSS SUPPORT – NEMA STANDARD

Supports for horizontal cross fittings should be located at a distance, no greater than 610 mm (24") from each end of the fitting on the attached ladder. Fitting should also be supported once on each siderail.

For 305 mm (12") radius cross, place supports no greater than 610 mm (24") from each end of the fitting on the attached ladder.

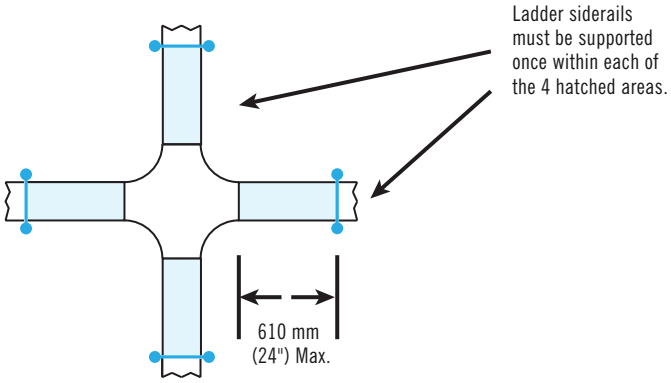
DIAGRAM D.20.A HORIZONTAL CROSS SUPPORT – NEMA STANDARD



D.4.1.3.B HORIZONTAL CROSS SUPPORT – ELIMINATE FITTING SUPPORT

Supports for horizontal cross fittings should be located at a distance, no greater than 610 mm (24") from each end of the fitting on the attached ladder. Fitting supports are eliminated.

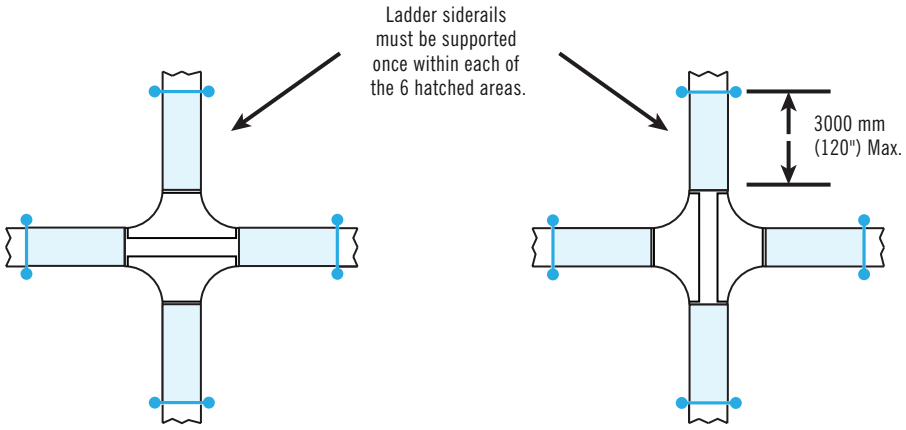
DIAGRAM D.20.B HORIZONTAL CROSS SUPPORT – ELIMINATE FITTING SUPPORT



D.4.1.3.C HORIZONTAL CROSS SUPPORT – EXTEND DISTANCE OF SUPPORT

Supports for horizontal cross fittings should be located at a distance, no greater than 3000 mm (10') max. from each end of the fitting on the attached ladder. Fitting supported twice within defined area.

DIAGRAM D.20.C HORIZONTAL CROSS SUPPORT – EXTEND DISTANCE OF SUPPORT



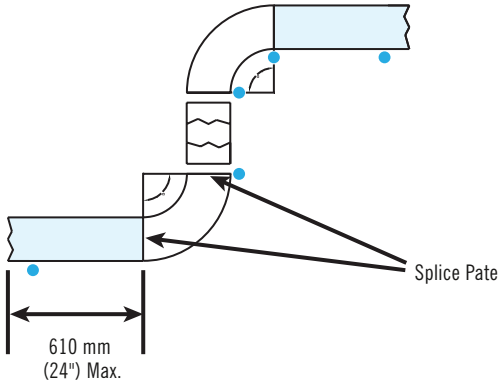
D.4.1.4 VERTICAL INSIDE/OUTSIDE SUPPORTS

D.4.1.4.A VERTICAL INSIDE/OUTSIDE SUPPORTS – NEMA STANDARD

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 610 mm (24") of the lower extremity of the elbows.

Both Inside and Outside Fittings should be additionally supported at a distance no greater than (24") from each end (2).

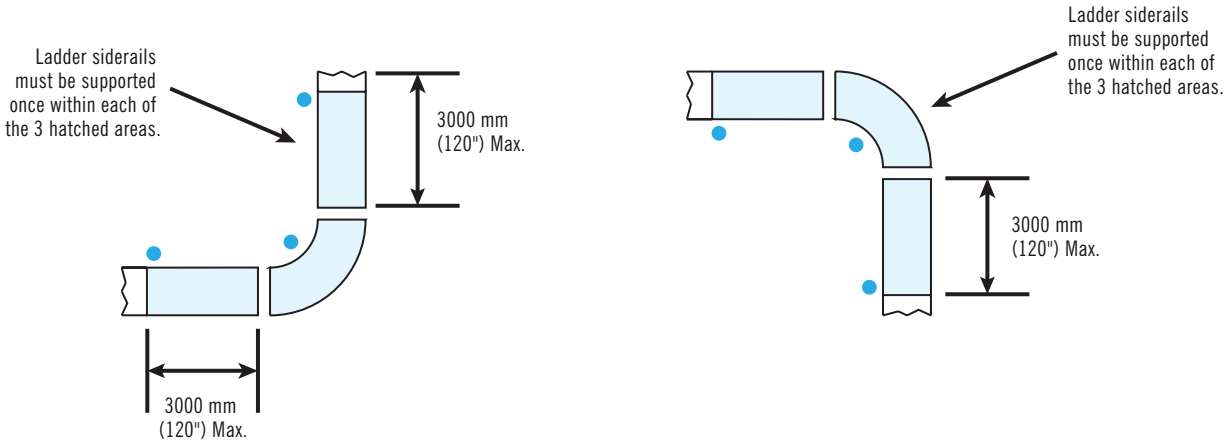
DIAGRAM D.21.A VERTICAL INSIDE/OUTSIDE SUPPORTS – NEMA STANDARD



D.4.1.4.B VERTICAL INSIDE/OUTSIDE SUPPORTS – EXTEND FITITNG SUPPORT

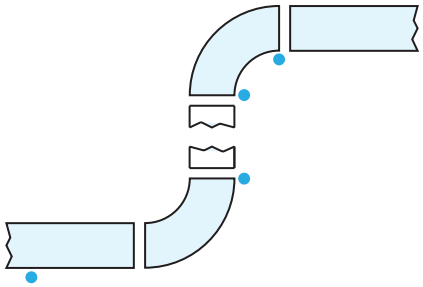
Supports for vertical fittings should be located at a distance, no greater than 300.

DIAGRAM D.21.B VERTICAL INSIDE/OUTSIDE SUPPORTS – ELIMINATE FITTING SUPPORT



D.4.1.4.C VERTICAL INSIDE/OUTSIDE SUPPORTS WITH STRAIGHT LADDER EXTENSION BETWEEN FITTINGS – EXTEND DISTANCE OF SUPPORT

DIAGRAM D.21.C VERTICAL INSIDE/OUTSIDE SUPPORTS – EXTEND DISTANCE OF SUPPORT



D.4.1.5 HORIZONTAL WYE SUPPORTS

D.4.1.5.A HORIZONTAL WYE SUPPORT – NEMA STANDARD

Place horizontal supports at a distance no greater than 610 mm (24") fraom each of the three (3) openings and at the midpoint of the fitting at 22.5°.

DIAGRAM D.22.A HORIZONTAL LEFT WYE SUPPORT – NEMA STANDARD

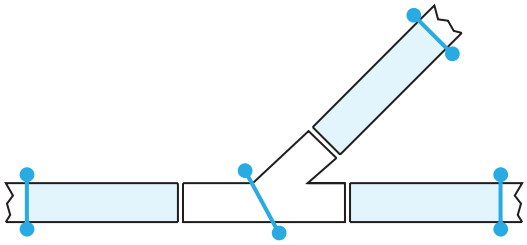
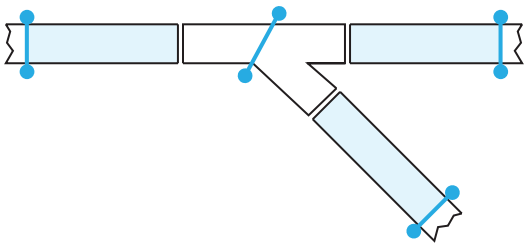


DIAGRAM D.22.B HORIZONTAL RIGHT WYE SUPPORT – NEMA STANDARD



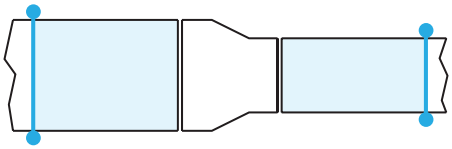
D.4.1.6 REDUCER SUPPORTS

D.4.1.6.A REDUCER SUPPORTS – NEMA STANDARD

Place horizontal supports (2) at a distance no greater than 610 mm (24") from each end.

DIAGRAM D.23.A LEFT/RIGHT REDUCER SUPPORTS

DIAGRAM D.23.B STRAIGHT REDUCER SUPPORTS

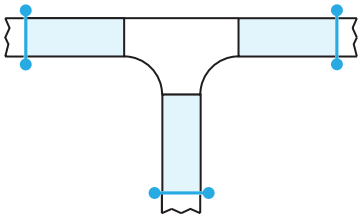


D.4.1.7 VERTICAL CABLE TRAY TEE SUPPORTS

D.4.1.7.A VERTICAL CABLE TRAY TEE SUPPORT – NEMA STANDARD

Each of the three (3) openings should be supported at a distance no greater than 610 mm (24") from its end point.

DIAGRAM D.23.A VERTICAL CABLE TRAY TEE SUPPORT – NEMA STANDARD



D.5: FIELD MODIFICATIONS (ALTERATIONS)

At some point during the project, a standard length of tray may have to be cut. If time and economies permit, Unitray can fabricate non-standard lengths. If there are many field cuts to be made, a cut list should be made to keep off cuts to a minimum.

D.5.1: MARKING (DIAGRAMS D.25 AND D.26)

Using a 610 mm (24") square [for tray up to 600 mm (23.6") wide] or two squares (for tray wider than 600 mm) overlaid so that Diagram D.26 is duplicated for each siderail, mark the tops of both flanges. Next, position the square as shown in Diagram D.27 and transfer the mark on the top flanges to the webs of the siderails.

DIAGRAM D.25

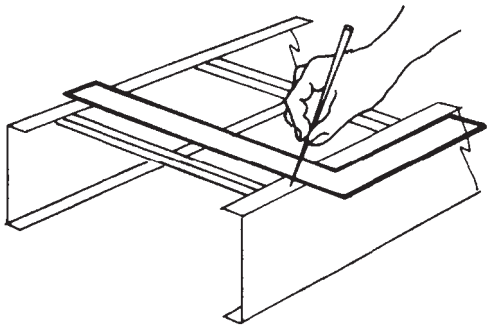
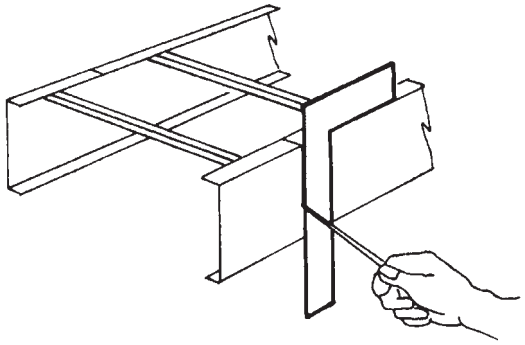


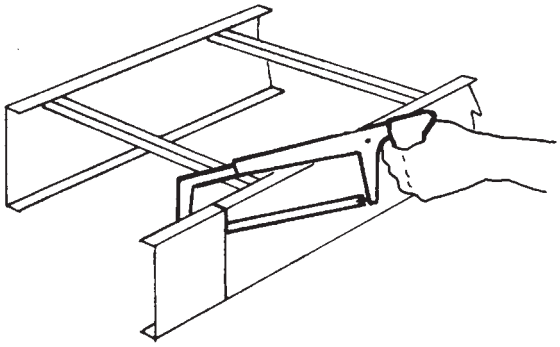
DIAGRAM D.26



D.5.2: CUTTING (DIAGRAM D.27)

These cuts can be made with either a 7 1⁄2" circular saw with a carbide tipped blade, a sawzall or a hand held hacksaw. The use of a suitable cutting lubricant (e.g. pure turpentine for aluminum) will speed up the process as well as preserve the cutting blades. In order to get an adequate splice connection it is important to get a 90 degree (to the longitudinal axis) cut. After cutting, use a file to deburr any rough edges.

DIAGRAM D.27



D.5.3: DRILLING (DIAGRAMS D.28, D.29, AND D.30)

All holes for connector plates must be drilled. The correct drill size is relative to the hardware being used on the ladder tray. In the case of carriage bolts and a corresponding square or rectangular hole, replace with a round or truss head machine screw of a slightly larger diameter than that of the carriage bolt (e.g. from 1/4" to 5/16" or 3/8"). Factory supplied or field built templates (Diagram D.30) can be used as a locator for the holes. Using a standard connector plate as a template is the most common means of locating the drill holes. Diagrams D.31 and D.32 illustrate when a short piece of siderail with a universal connector already bolted on, is clamped to the field cut section and used as a template. These two rail sections must be flush with one another. Care must be taken while drilling to prevent the distortion of the holes in the template connector. The number of holes to be drilled and the preciseness of the drilling may dictate the use of more than one universal connector as a template.

DIAGRAM D.28

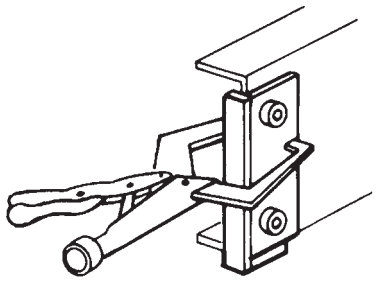


DIAGRAM D.29

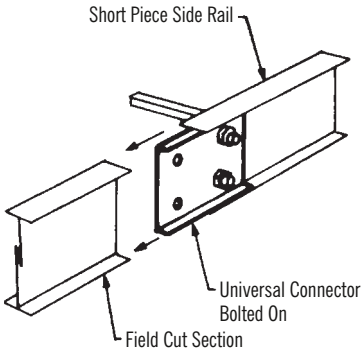
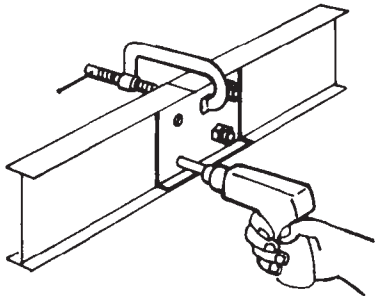


DIAGRAM D.30



D.5.4: FIELD TOUCH UP

Neither aluminum nor Type II (pre-galvanized) ladder trays have to be touched up. Type II trays are to be used primarily indoors and in non-corrosive environments. If corrosion is a concern, then new holes and cut edges may be painted with Galvcon. This can be sprayed or brushed on.

Type I ladder trays must be touched up with approved zinc based paint (e.g. Galvcon). The applied (spray or brush) coating must extend 25 mm (1") past the bare area.

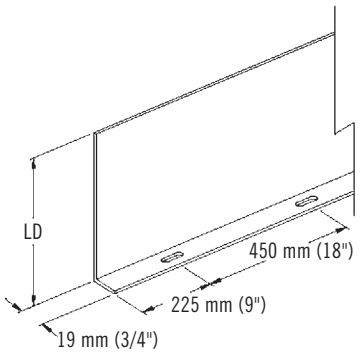
For other tray with different coatings, a protective coating of compatibility must be applied. The architect is usually the contact person who will determine the means of application and the thickness of the field coating.

D.6: ANCILLARY PRODUCTS / ACCESSORIES (DIAGRAMS D.31 TO D.42)

D.6.1: BARRIER/DIVIDER STRIPS (DIAGRAMS D.31 THROUGH D.38)

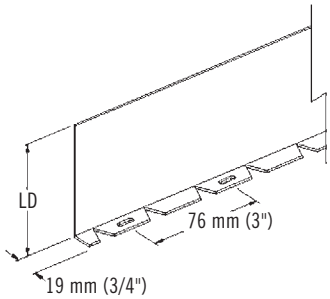
Per CEC Rule 12-904, Subrule (2), Paragraph (b) which states "...are separated by a barrier of sheet steel not less than 0.0528 inch (No. 16 MSG) thick or a flamed-retardant nonmetallic insulating material not less than 1.5 mm in thickness; or..."

DIAGRAM D.31
BARRIER STRIP-STRAIGHT SECTION



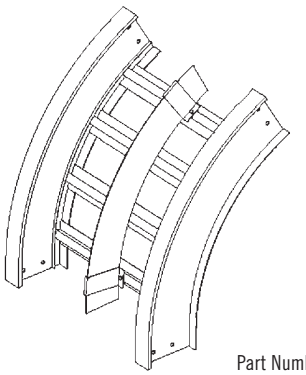
Part Number: SB

DIAGRAM D.32 BARRIER
STRIP-HORIZONTAL FITTING



Part Number: FB

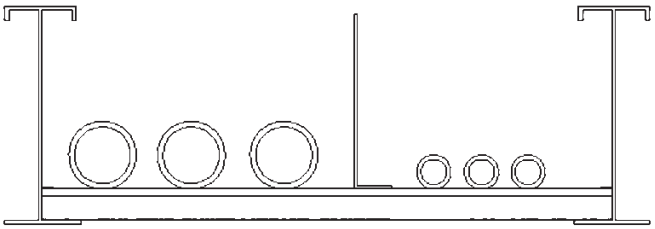
DIAGRAM D.33 BARRIER
STRIP-VERTICAL FITTING



Part Number OB/IB

Barrier strips are used in ladder trays containing conductors connected to different power or distribution transformers or other different sources of voltage. For straight lengths of tray, the barriers are placed at required locations and then fastened every 900 mm (36") by either #10 x 1/2" self-drilling and self-tapping screws or clamps (BC). For barriers used on vertical fittings, there should be a minimum of three (3) attachment points. For straight length barriers (SB) straight alignment can be achieved by the use of splice connectors (PSS). The height of the barrier strip must not be greater than the loading depth of the ladder tray.

DIAGRAM D.34 BARRIER STRIP APPLICATION



SBA-(*)

DIAGRAM D.35 BARRIER STRIP ATTACHMENT, SELF DRILLING & SELF TAPPING SCREW

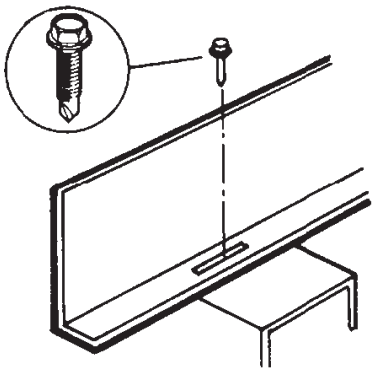
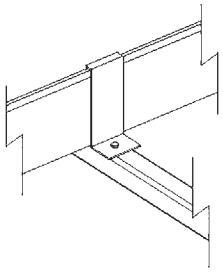
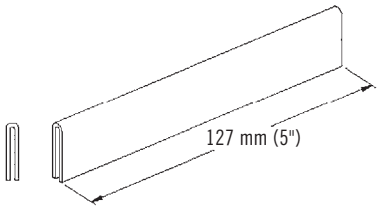


DIAGRAM D.36 BARRIER STRIP ATTACHMENT, BARRIER CLIP (OPTIONAL)



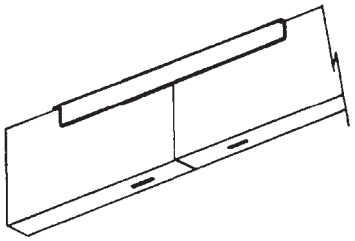
Part Number: BC

DIAGRAM D.37 BARRIER STRIP SPLICE



Part Number: PSS

DIAGRAM D.38 BARRIER STRIP SPLICE INSTALLED



D.6.2: CABLE DROP-OUTS (DIAGRAM D.39 AND D.40)

Please reference CEC Rule 12-906, for the termination of armored cable. Dropouts are available in 100 mm (4") radius to provide a means of cable exiting both ladder tray and communication channel. They provide a smooth surface on the radius face to protect the sheathing of the cable. There are two types: snap on or drop in (inserted between rungs). Both types are secured in place with #10 x 1⁄2" self-drilling and self-tapping tec screws.

DIAGRAM D.39 LADDER DROP-OUT

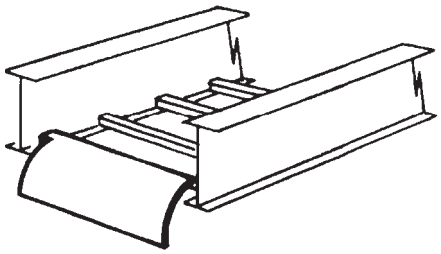
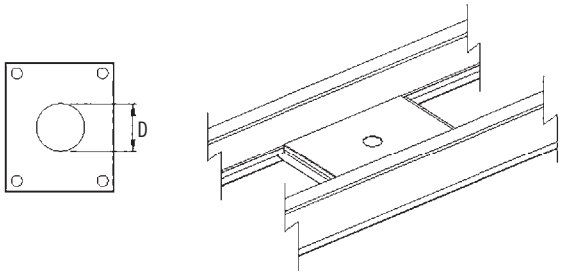


DIAGRAM D.40 CONDUIT DROP-OUT BUSHING

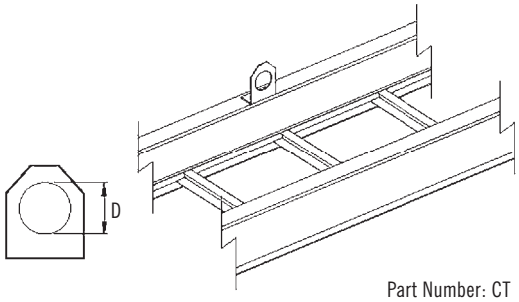


Part Number: BB

D.6.3: CONDUIT TO TRAY ADAPTER (DIAGRAMS D.41 AND D.42)

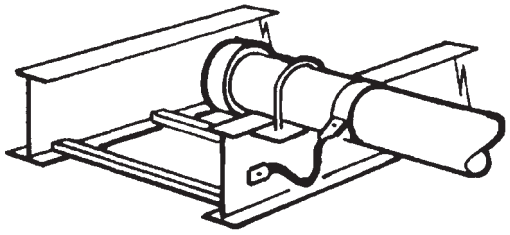
This adapter (CT) is used when a conduit run terminates at a ladder tray run. This is a mechanical connection. In order to maintain electrical continuity an equipment grounding connection must be established between the ladder tray and the conduit (Diagram D.42). To fasten this adapter to the top flange field, drill two (2) 3/8" holes, insert bolts from the top, fasten nuts and tighten in place.

DIAGRAM D.41 CONDUIT TO LADDER TRAY ADAPTER



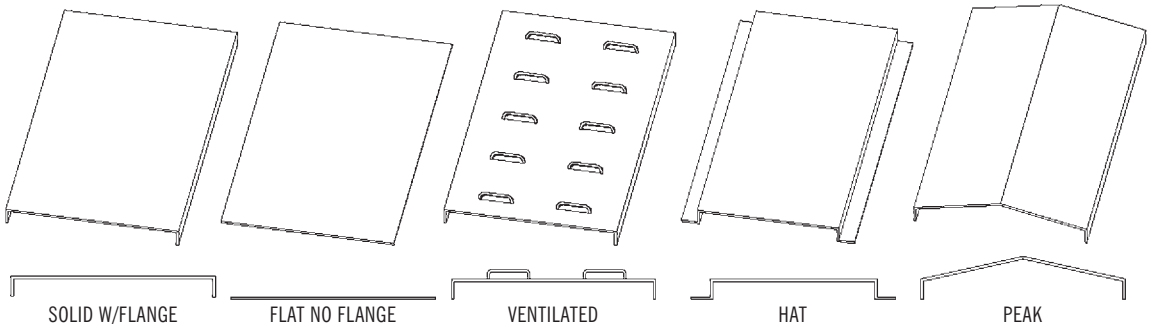
Part Number: CT

DIAGRAM D.42 INSTALLED CONDUIT TO LADDER TRAY ADAPTER



D.6.4: TRAY COVERS AND CLAMPS (DIAGRAM D.434 AND D.44)

DIAGRAM D.43



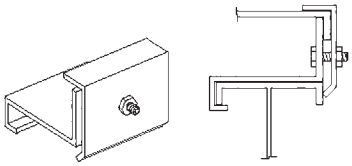
Where conductors in ladder tray require permanent mechanical protection (CEC Rule 12-2202 Subrule (2) Paragraph b and Subrule 3) covers have to be installed. See samples in Diagram D.44. Ventilated (V) covers are used when heat build up within the tray is a concern. Hat (H) covers as well as raised cover clamps (CE) are used when the level of cables installed in the tray is at, or protrude above the top flangeof the side rail. When vertical ladder trays penetrate dry floors they must be covered for 2 meters abovethe floor.

Refer to Diagram D.44 for some of the of the various means of affixing the covers to the ladder tray. Per NEMA V2, installing cover on outdoor cable tray systems is not common practice. Should they be required, proper attachment is required to protect them from the force of the wind.

DIAGRAM D.44 LADDER TRAY COVER HARDWARE

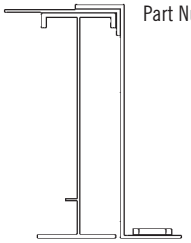
A. RAISED COVER CLAMP (INDOOR SERVICE ONLY)

Part Number: CE



B. COMBINATION COVER AND HOLD-DOWN CLAMP (INDOOR SERVICE ONLY)

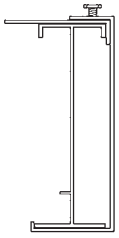
Part Number: HC



C. SELF-DRILLING & SELF TAPPING SCREWS (INDOOR/ OUTDOOR SERVICE)

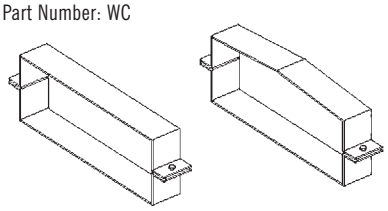
D. STANDARD COVER CLAMP (INDOOR SERVICE ONLY)

Part Number: CV



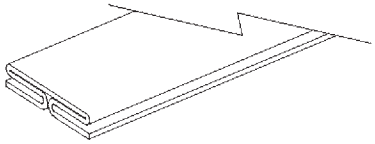
E. HEAVY DUTY DOUBLE COVER CLAMPS (INDOOR/ OUTDOOR SERVICE)

Part Number: WC



F. COVER JOINT STRIP (USED TO JOIN COVERS – OPTIONAL)

Part Number: CJ



COVER APPLICATION	NUMBER OF WRAP-AROUND CLAMPS REQUIRED
Straight Covers (3M)	3 Pieces
Horizontal Covers	2 Pieces
Vertical Covers	2 Pieces
Horizontal Tee Covers	2 Pieces
Horizontal Cross Covers	4 Pieces

D.7: GROUNDING OF LADDER TRAY (DIAGRAM D.45)

Excerpts from Canadian Electrical Code

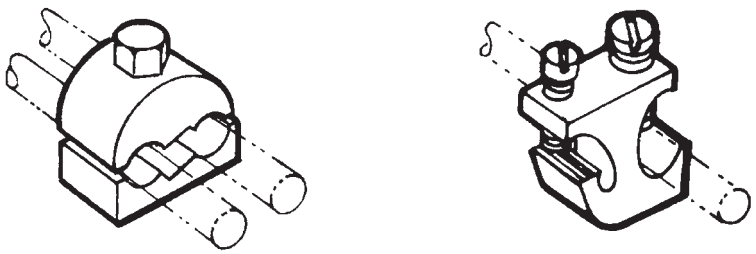
The tray system must have a permanent and continuous conductive path to the ground with sufficient ampacity to carry any fault current liable to the imposed on it. It must be of sufficient low impedance to limit the voltage rise above ground and able to facilitate the operation of the protective devices (circuit interrupters) in the circuit. The tray system must protect life and property against faults caused by electrical disturbances, failure of equipment that is connected to the tray system and failures that are part of the system. Therefore, all metal enclosures of the system, together with non-current carrying or neutral conductors should be connected and reduced to a common earth potential.

A grounding system includes all conductors, clamps, ground clips, ground pipes and ground electrodes by which the electrical installation is grounded. Excerpt from CEC Rule 10-700 listing the more common forms of grounding electrodes:

1. Grounding electrodes shall consist of
   (a) manufactured grounding electrodes;
   (b) field-assembled grounding electrodes installed in accordance with this Rule; or
   (c) in-situ grounding electrodes forming part of existing infrastructure as defined in this Rule.
2. Manufactured grounding electrodes shall
   (a) in the case of a rod grounding electrode, consist of 2 rod electrodes (except for a chemically charged rod electrode where only one need be installed) spaced no less than 3 m apart
      (i) bonded together with a grounding conductor sized in accordance with Rule 10-812; and
      (ii) driven to the full length of the rod; or
   (b) in the case of a plate electrode, be
      (i) in direct contact with exterior soil at no less than 600 mm below grade level; or
      (ii) encased within the bottom 50 mm of a concrete foundation footing in direct contact with the earth at not less than 600 mm below finished grade.
3. A field-assembled grounding electrode shall consist of
   (a) a bare copper conductor not less than 6 m in length, sized in accordance with Table 43 and encased within the bottom 50 mm of a concrete foundation footing in direct contact with the earth at not less than 600 mm below finished grade; or
   (b) a bare copper conductor not less than 6 m in length, sized in accordance with Table 43 and directly buried in earth at least 600 mm below finished grade.
4. For the purposes of Rule 2-024, an in-situ grounding electrode shall not be considered electrical equipment and shall provide, at 600 mm or more below finished grade, a surface area exposure to earth equivalent to that of a similar manufactured electrode.
5. Where a local condition such as rock or permafrost prevents a rod or a plate grounding electrode from being installed at the required burial depth, a lesser acceptable depth shall be permitted.

The grounding conductor of a wiring system may be insulated or bare, and shall be of copper, aluminum or other acceptable material. To fasten a separate conductor in ladder tray as a ground it can be attached to the tray with a grounding clamp (Diagram D.46). These may be either:
a) beam type clamp or b) a bolt on clamp that requires field drilling to the siderail.

DIAGRAM D.45 GROUNDING CLAMPS



The National Electrical Code, Article 392-7 allows cable tray to be used as an equipment grounding conductor. All Unitray standard cable trays are classified by Underwriter's Labortories per US NEC Table 392-7 based on their cross sectional area. The corresponding cross-sectional area for each siderail design (2 siderails) is listed on the label. This cable tray label is attached to each straight section that is UL classified.

GROUNDING AND BONDING

TABLE 1 (NEC TABLE 392.7 (B))
METAL AREA REQUIREMENTS FOR CABLE TRAYS USED AS EQUIPMENT GROUNDING CONDUCTORS

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

For SI units: one square inch = 645 square millimeters.

* Total cross-sectional area of both side rails for ladder or trough-type cable trays: or the minimum cross-sectional area of metal in channel-type cable trays or cable trays of one-piece construction.

** Steel cable trays shall not be used as equipment grounding conductors for circuits with ground-fault protection above 600 A. Aluminum cable trays shall not be used as equipment grounding conductors for circuits with ground-fault protection above 2000 A.

For larger ampere ratings an additional grounding conductor must be used.

TABLE 2 (BASED ON NEC TABLE 250-95 AND CEC TABLE 16)
MINIMUM SIZE EQUIPMENT GROUNDING CONDUCTORS FOR GROUNDING & BONDING RACEWAY AND EQUIPMENT

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

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

D.7.1: BONDING OF LADDER TRAY

Bonding is the existence of a low impedance path obtained by permanently joining all non-current carrying metal parts to the service equipment or the system grounding conductor. This must ensure electrical continuity and have the capacity to safely conduct any current likely to be imposed on it.

RULE 12-2208: Provisions for Bonding

1. Except as provided for in Subrules (2) and (3), metal cable tray shall be bonded at intervals not exceeding 15 m and the size of bonding conductors shall be based on the ampacity of the largest ungrounded conductor as specified in Rule 10-814 in the circuits carried by the cable tray.
2. Where metal supports for metal cable trays are bolted to the tray and are in good electrical contact with the grounded structural metal frame of a building, the tray shall be deemed to be bonded to ground.
3. Notwithstanding Rule 12-2200(1) and Section 10, metal cable tray is not required to be bonded to ground where all of the cables contained within the tray:
   (a) have an interlocking metal armour; or
   (b) have a continuous metal sheath that is permitted to be used as a bonding method.
4. All metal cable tray that is not bonded in accordance with Subrule (3) shall have a permanent, legible warning notice carrying the wording "INTERLOCKING METAL ARMOUR CABLES OR CONTINUOUS METAL SHEATH CABLES ONLY", or equivalent, placed in a conspicuous position with the maximum spacing of warning notices not to exceed 10 m.

RULE 10-814: Bonding Conductor Size (See Appendix B)

1. The size of a bonding conductor shall be not less than that given in
   (a) Table 16A for wire and cable installations; or
   (b) Table 16B for busbar installations.
2. Notwithstanding the requirements of Rule 12-108, the size of the bonding conductor in each parallel run shall be permitted to be smaller than No. 1/0 AWG.
3. Where circuit conductors are paralleled in separate cables, raceways, or busbars, the bonding conductor shall be paralleled and the size of bonding conductor in each parallel run shall not be less than that specified in:
   (a) Table 16A based on the size of the associated circuit conductors contained in the raceway or cable; or
   (b) Table 16B based on the ampacity of the associated busbar.
4. Notwithstanding Subrules (1), (2), and (3), the bonding conductor shall be permitted to be not larger than the largest ungrounded conductor in the circuit.

The contact surfaces of all metals must be free of non-conductive coatings such as paint and grease to ensure adequate bonding. The use of dissimilar metals should be avoided whenever possible to prevent galvanic action (corrosion). An example of this would be the use of bare copper as a bonding conductor in aluminum tray. Metallic tray by itself is not considered a positive grounding path, but it still must be able to conduct current. When a separate bonding conductor is required to supplement the bonding offered by a ferrous metallic tray system it must be installed inside the tray along with the circuit conductor.

Please refer to Table 16 of the CEC for minimum size of conductors required for bonding ladder tray to service equipment.

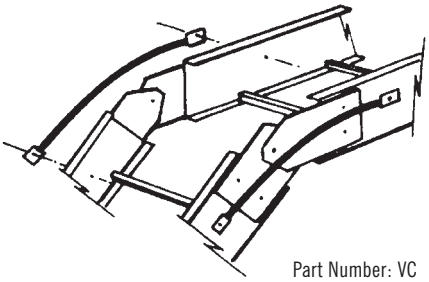
When the run of the ladder tray is interrupted (the cross-sectional area of the siderail is compromised), then bonding jumpers should be installed around that break. If a separate conductor is used as a ground throughout the entire length of the tray run, then bonding jumpers are not required. This bonding jumper must be:

i. corrosive resistant material (e.g. copper), and
ii. of sufficient size to have an ampacity not less than that required for the corresponding grounding conductor.

If a bonding strap is used for bonding non-current-carrying metal parts, it must have the following dimensions:
STEEL: minimum width 19 mm (3/4"), minimum thickness 1.4 mm (.055")
ALUMINUM/COPPER: minimum width 19 mm (3/4"), minimum thickness 1.2 mm (.047")

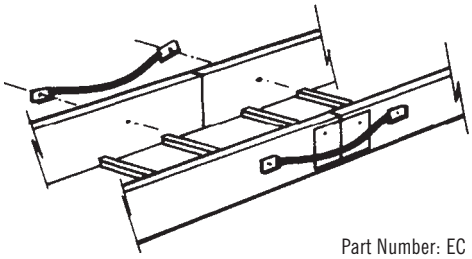
At standard rigid connections, bonding jumpers do not have to be installed. Diagrams D.47 to D.49 illustrate some of the more common applications for bonding jumpers.

DIAGRAM D.47 VERTICAL CONNECTORS



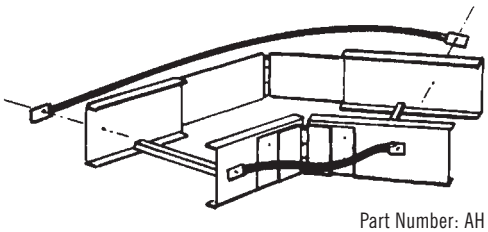
Part Number: VC

DIAGRAM D.48 EXPANSION CONNECTORS



Part Number: EC

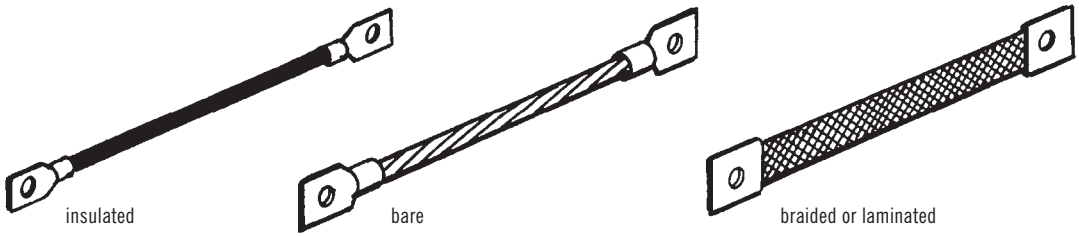
DIAGRAM D.49 HORIZONTAL ADJUSTABLE ELBOW



Part Number: AH

Always size bonding jumpers to Table 16 of the CEC Bonding jumpers may be insulated, bare, or laminated.

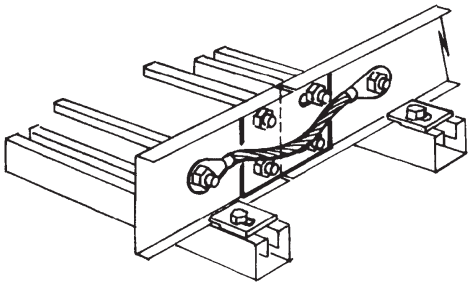
DIAGRAM D.50 BONDING JUMPERS



D.7.2: INSTALLATION OF BONDING JUMPERS (DIAGRAM D.51)

If holes have not been factory punched, then field drill 3/8" diameter holes (2), one on each side of the connector plate. These holes must be a minimum of 50 mm (2") from the end to the connector plate. Do not use connector plates to affix the bonding jumper. Insert bolt so that the inside of the bolt head is on the inside of the side rail of the ladder tray. Position the jumper on the outside of the siderail, add flat washer, locknut and tighten.

DIAGRAM D.51 EXPANSION CONNECTION



SECTION E: INSTALLATION OF CABLE

E.1: INTRODUCTION

The following guideline contains some of the more common site procedures for the installation of cable. Prior to the install, consult with the cable manufacturer (or closest technical representative) to obtain all technical data. This data should include storage temperatures, cable weight per foot, minimum and maximum sidewall pressures, and recommended installation procedures (e.g. field splices, bending radii and pulling tools).

E.2: STORAGE AND HANDLING

i. As with the receipt of any other product, note any discrepancies, shortages and damages, using both the suppliers packing slip and the carrier's Bill of Lading. Notify both parties if any of the above are an issue.
ii. Care must be used in offloading cable reels, to prevent contact with the cable. The reels may be hoisted off the truck using a metal support (pipe) placed through the center of the reel. If a forklift is used, the tynes (forks) must contact both reel flanges. The reel should be positioned as close to the forklift mast as possible to ensure load stability. Prior to maneuvering the forklift, lower the reel to give adequate ground clearance. At no stage in offloading or transporting should the reels be dropped.
iii. There is a right way as well as a wrong way to roll the reels. Prior to rolling, make sure that the end of the cable in the reel is properly secured. The outside of the reel is often times marked with an arrow to indicate the direction to roll the reel. If the cables are rolled in the wrong direction cables will slacken in the reel, leading to difficulties later on in off-loading the cable (de-reeling). The right direction for rolling is the opposite direction to the direction that the cable is wrapped onto the reel. When rolling the reels make sure the direction and the rate of roll is controlled.
iv. When storing the cable reels, choose an area that will minimize both physical and environmental contact with the cables. Ensure that other subtrades or inexperienced personnel are not involved in moving the reels. Cable reels should be stored indoors away from the dangers of falling objects and chemical contamination. If they have to be stored outdoors, do not store in temperatures below that recommended by the manufacturer. They should be sufficiently covered to prevent damage from moisture and ultraviolet rays. Cable ends are to be sealed. Reels should not be placed on their sides, and should be chocked on sufficient dunnage to prevent any moisture contact. They should be stored in a fashion that allows removal of the reels based on their priority of use.

There should be no installation of the cable below the temperature rating that is marked on the cable. The ladder tray system must be complete before the cable/conductors are installed. The ladder tray system must be free of any hazards, which will interfere with the cable's install. Any ongoing or anticipated construction operations that may damage the cable or create a safety hazard to personnel should cause the delay of the cable install. One should only proceed when it is safe to do so.

The cable manufacturer must be contacted to obtain the following technical data:
i. the field installation of both a basket grip and a pulling eye
ii. the proper size and spacing requirements of pulleys and rollers
iii. the recommended bending radius of each size and type of cable
iv. the maximum cable pulling speed and corresponding tension

When drawing/pulling cables into ladder tray, the tray run between outlets or draw-in points should not have more than the equivalent of four (4) 90 degree bends including the bends located at an outlet or fitting (CEC Rule 12-942).

For some tray runs, short lengths of cable may be laid in place without being pulled in. Where cables have to be drawn in, the use of pulling equipment is required.

E.3: HORIZONTAL STRAIGHT RUNS

If rollers are required they should be located within or on top of the tray. The assembly itself must be securely fastened to prevent both movement during pulling and damage to the ladder tray. The rollers should be affixed to a position as close to a ladder tray horizontal support as physically possible. Spacing should be such that the cables do not sag nor drop during pulling. Rollers should be space at 5 m (16') intervals for cable weighing over 19 kg/m (12.8 lbs/ft). For conductors weighing over 75 kg/m (50 lbs/ft) the intervals should be 3 m (10'). When pulling conductors of mixed diameters and weights at the same time, the spacing interval should be based on the heaviest cable.

E.4: HORIZONTAL AND VERTICAL BENDS

Pulleys and sheaves are used to maintain the minimum bending radius of the conductor throughout the pull. At some bends more than one of the above may be required to maintain the minimum bending radius at both the entrance and exit points of the bend. Proper sizing of these tools is a must. The cable must transfer through these tools smoothly without being damaged. There can be a considerable amount of pressure applied to the pulling devices due to the length and weight of the cable weight. They must be anchored to the structural steel and not to the tray itself. The tray is not designed to withstand the substantial side pressures that can be applied during pulling.

E.5: PULLING THE CABLE (DIAGRAMS D.52 THROUGH D.56)

Basket grips/pulling eyes may have to be attached to the pulling end for larger metallic cables **(Diagrams D.52 and D.53)**. These can either be installed by the manufacturer, or by experienced field personnel. Basket grips are commonly used for pulling cables with diameters up to 50 mm (2"). The tail end of the basket grip is taped to the cable. Pulling eyes/bolts are used for larger cables. This device pulls the conductor as well as its sheathing, braiding or armoring. A basket grip that has the conductor affixed to the eye and its tailing end tapped around the outside of the conductor may also be used. Make sure all surfaces of the pulling devices that come in contact with the cable and ladder tray are covered by a protective covering of plastic or tape to prevent surface scoring. All axles on pulling devices must turn freely while under load. A device to record accurate pulling tensions should be installed at the pulling end. This will ensure that the manufacture's tensile limits are not exceeded. Personnel should be placed at either end of the pull. Where hand signals are not possible for communication during a pull, personnel should be radio/cell phone equipped. Caution must be exercised during the pull to prevent the crossing of the cable during de-reeling and from exceeding the cables tension and pulling speed. At the cable reel end (de-reeling) personnel must have a means of braking the reel to prevent slackness of the cable. Make sure enough cable is pulled to allow for making of electrical connections and removal of pulling attachments on the cable.

DIAGRAM D.52 PULLING EYE

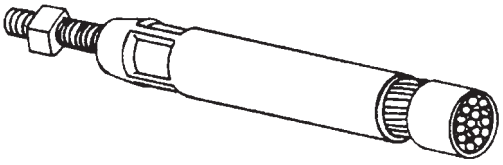
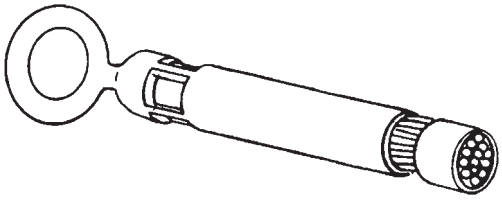


DIAGRAM D.53 PULLING BOLT



Once the cable has been pulled through the entire system, care must be exercised in removing the pulling devices. The cable must not be dropped, but laid into the tray. If electrical connections are not made immediately, the ends of the cable if sheathed, should be sealed from moisture contamination.

DIAGRAM D.54 STRAIGHT ROLLER (TOP MOUNTED)

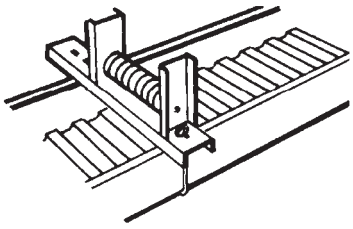


DIAGRAM D.55 TRIPLE PULLEY GUIDE

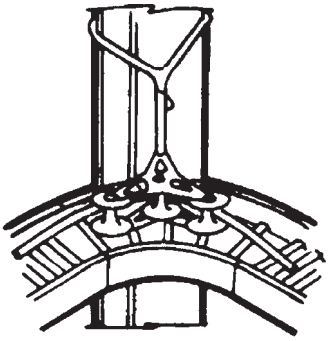
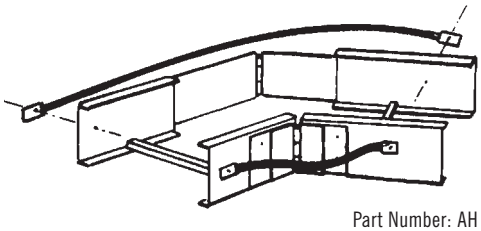


DIAGRAM D.56 90° ROLLER



Part Number: AH

E.6: CABLE FASTENING

Reference should be made to CEC Part 1, Table 21 for cable support distances for conductor size. Cable or "P" clamps and plastic tie wraps are used to fasten cables/conductors to the ladder tray. Single conductors must be fastened to prevent excessive movement generated by fault current magnetic forces. Fastening to single conductors will maintain adequate spacing as well as confining the cable within the planned cable fill area. Care should be exercised while tightening the fastener to prevent the indentation of the jacket of the cable.

Stainless Steel [CEC RULE 12-2202 (5)] clamps should only be used on vertical runs. In many cases the weight of the cable will exceed the load carrying capacity of the tray component as well a the maximum allowable cable tension.

The cable load must be fastened to as many points as possible to evenly distribute the cable load within allowable limits.

E.7: PROTECTION OF INSTALLED CABLE

Once the cable is in the tray, permanent covers should be installed as quickly as possible. Temporary covers should be applied to the tray to protect the system where the possibility of damage exists. Exposed ends and connections should be physically protected from accidental contact. Prominent and distinct warning signs must stay in place until those areas are secured.

No unapproved personnel should work on a live system. Approved personnel must be protected by properly maintained and approved insulated devices (e.g. rubber gloves and boots, and hand tools). Accessibility to the system should be adequate as well as controlled.

SECTION F: MAINTENANCE

F.1: INSPECTION

No part of the ladder tray system that is subject to regular inspection or maintenance should be rendered inaccessible due to future construction. Passageways and working spaces should not be used for storage and must be free of obstructions to permit easy access to all maintenance items. For the most part, a ladder tray system requires little in the way of inspection or maintenance. All fastening devices should be checked periodically for looseness. Tighten all loose hardware. Areas of penetration should be checked for fit and tightness of seal.

Deposits of dust, foreign objects and debris should be removed to reduce the potential of fire. Severe weather or any abnormal event would justify a complete inspection of the entire system.

F.2: REMOVING OR ADDING CABLES

Inactive or dead cables should be removed from the tray system. The benefits are:

i. makes the system more efficient through increased tray capacity and greater cooling of the remaining conductors, and
ii. less time spent by electricians routing inactive cables

When adding cable to an existing system, please make reference to the section on **SIZING OF LADDER TRAY** as well as **CEC Rule 12-2210** for allowable cable fill.

Please reference Section E of this article as well as the cable manufacturer's procedures for the installation of cable/conductors.

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