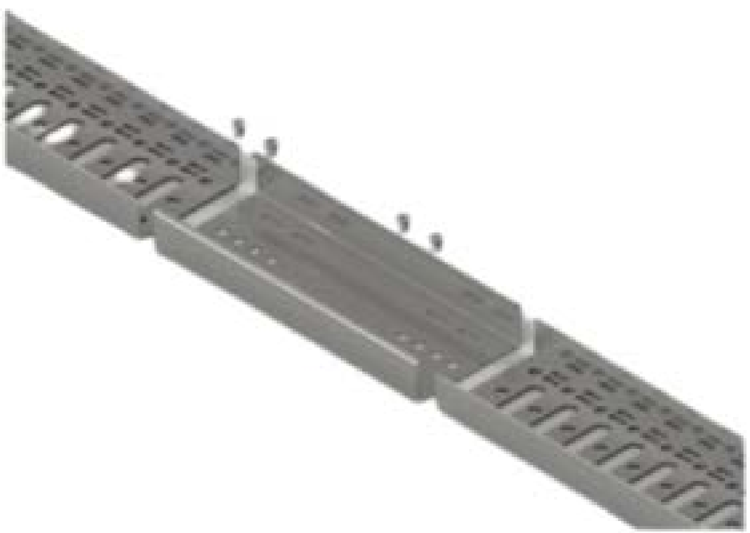

Snap Track Design Manual

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Introduction

The technical staff of TechLine Mfg. has produced this manual to assist engineers and contractors with the proper understanding and application of the unique Snap Track system. As the use of limited-width ventilated-bottom channel tray has become more prevalent in industry, many questions have arisen. In some cases, ventilated channel tray systems have been misapplied or under applied based on the code requirements for other types of cable tray systems and or existing end-user standards.

This manual addresses the many aspects and considerations associated with the intended use of the Snap Track system. If additional information is required or if specific questions arise, please contact TechLine Mfg.

The information contained in this manual has been independently checked for accuracy and is believed to be correct and current. However, no warranty, either expressed or implied, is made as to applicability or compatibility with specific code requirements. In all cases it is the responsibility of the designer or end user to refer to the applicable current codes and or standards for their specific installation.

TechLine Mfg.

30516 Sgt. E.I. Boots Thomas Dr.
Spanish Fort, AL 36527
Tel: (800) 395-3369
Fax: (251) 380-7301
info@techlinemfg.com
www.techlinemfg.com

Overview

Snap Track was developed in response to a request for a limited-width tray system to replace wire basket tray in an industrial environment. A major oil company approached TechLine Mfg. requesting a product that would be stronger, provide better cable protection and reduce installation cost. Snap Track took almost five years in the design and development. After visiting with end users, engineering firms, contractors, installers, etc., Snap Track was developed with an even more expanded focus.

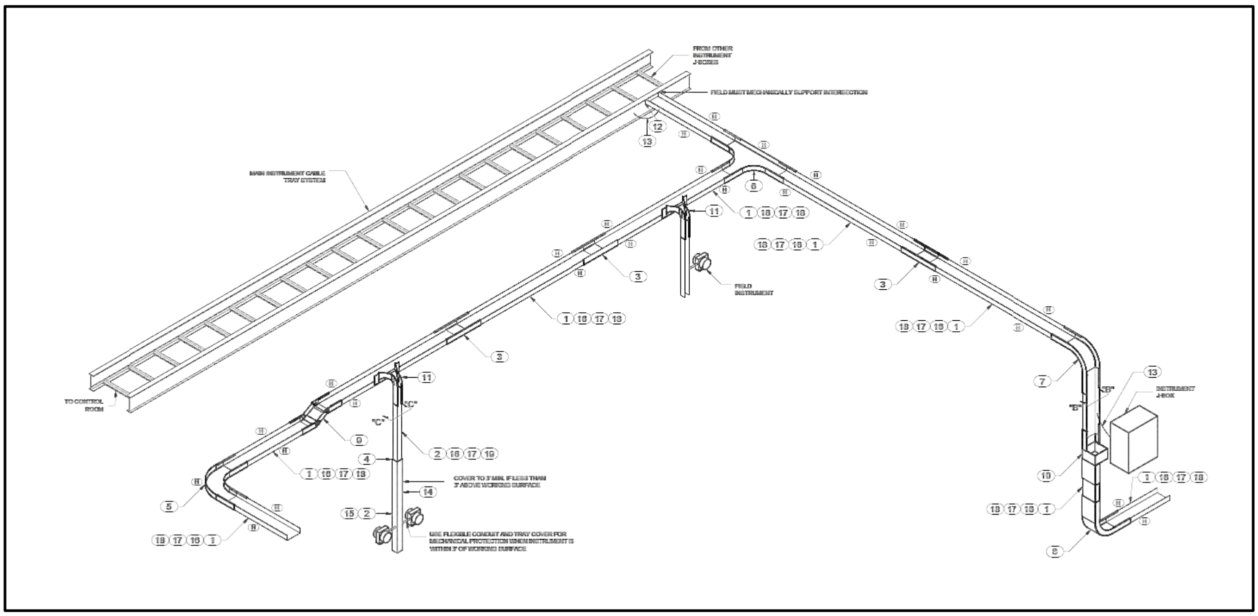
Our objective is to provide the following:

I. An innovative channel tray system designed to be an alternative to conduit, while providing an adequate degree of cable protection.

II. An alternative for transitioning from ladder tray to point-of-use in an industrial environment while providing an adequate degree of cable protection and dramatically reducing installation cost.

Snap Track is not a traditional ladder type or channel type cable tray but rather a unique limited-width, ventilated-bottom channel tray. Snap Track is intended to be used as an alternative to conduit, typically 2” and below, and traditional channel tray. Snap Track was introduced to transition low-voltage, control, and instrument cable from ladder tray to point-of-use i.e., instruments and motor control stations in an industrial environment.

Many commonly accepted benefits of running channel tray systems in lieu of conduit include lower total installed cost, cable accessibility, and future modifications in these applications. These benefits coupled with unique labor and material savings have proven to make Snap Track an effective alternative for not only routing low voltage, control cable, and instrument cable, but also service conductor or power cables.



Intended Use

The Snap Track system utilizes a ventilated bottom channel-type tray. The tray is an extruded structure having longitudinal side members that are integral with a ventilated bottom. The Snap Track system is an innovative multifaceted UL classified cable support. The system is classified by UL as suitable for use as an EGC when installed per NEC 2014 article 392. The system is suitable for use with power cables, multiple control, or signal cables in industrial (classified) applications when grounded per NEC article 250. Snap Track tray systems are typically used to support: a.) conductors enclosed in a continuous metal sheath or of the interlocked armor types, and b.) conductors having exposure-rated (ER test rating), non-metallic and moisture resistant insulation. Ventilated bottom trays are considered the best choice for preventing sagging of smaller cables. c.) The Snap Track system is not limited to these uses and is also suitable for non-industrial applications. Snap Track tray is also an ideal product for use as a mechanical support for instrument tubing.

Permitted Usage and Wiring Methods Under NEC.

Usage permitted under NEC section 392.10 – Cable trays are permitted to be used as a support system for service conductors, feeders, branch circuits, communication circuits, control circuits, and signaling circuits. Under this section it is noted that cable tray systems and therefore the Snap Track system is not limited to industrial establishments.

(A) Wiring Methods

The wiring methods in NEC Table 392.10(A) are permitted to be installed in the Snap Track systems under the conditions described in their respective articles and sections. The following guidelines should be followed when installing Snap Track as a cable tray system. (Partial most common list)

Table 392.10 (A) Wiring Methods (Partial List - Most Common)

Wiring Method For:	Article :	Wiring Method For:	Article :
CATV Cables	820	Network Powered Broadband Communication Cables	830
Class 2 and Class 3 Cables	725	Non-Powered Limited Fire Alarm Cables	760
Communication Cables	800	Optical Fiber Cables	770
Fire Alarm Cables	760	Power and Control Tray Cables	336
Instrument Tray Cables	727	Power Limited Fire Alarm Cables	760
Metal Clad Cables	330		

(B) In Industrial establishments:

The wiring methods in table 392.10 (A) are permitted to be used in any industrial establishment under the conditions described in their respective articles. In industrial establishments only, where conditions of maintenance and supervision ensure that only qualified persons service the installed Snap Track system, any of the cables in 392.10 (B) (1) and (B) (2) shall be permitted to be installed in ventilat ed channel trays i.e. Snap Track.

(B)(1) Single - conductor cables shall be permitted to be installed in accordance with 392.10 (B)(1)(a) through (B)(1)(c).

(a) Single conductor Cable shall be 1/0 AWG or larger and should be of a type listed and marked on the surface for use in channel trays.

(b) Single conductors used as equipment grounding conductors should be insulated, covered, or bare, and should be 4 AWG or larger.

(B)(2) Single – and multiconductor medium voltage cables shall be Type MV cable. Single conductors shall be installed in accordance with 392.10 (B)(1)

(C) Hazardous (Classified) Locations:

Channel Trays in hazardous (classified) locations should contain only the cable types permitted by NEC.

***Note**: In Hazardous (Classified) locations, limitations are on cable types NOT the Snap Track system.*

Usage NOT permitted under NEC section 392.12 – Cable tray systems shall NOT be used in hoist ways or where subject to severe physical damage. The designer should identify and avoid areas where severe cable damage may occur. Usually these areas are limited and the cable tray system can simply be rerouted.

Certain conditions may call for the use of totally enclosed tray systems. Local building codes should be examined to determine the suitability of a ventilated bottom tray.

It should be noted that NEC Section 300.80 states that cable trays containing electrical conductors shall not contain any pipe, tube, or equal for steam, water, air, gas, drainage, or any other service other than electrical. Therefore, separate tray systems should be installed when Snap Track is used both as a cable tray system and as a tubing raceway.

Material Compatibility

Material – Aluminum Alloys

Snap Track channel is extruded from alloy 6063 - T6 aluminum. This grade of aluminum comprises the series 6000 aluminum, classified by the Aluminum Association, and includes the addition of magnesium and silicone, magnesium silicide, which makes a stronger alloy that is further strengthened and enhanced by heat treating.

Alloy 6063 - T6 aluminum extrusions provide a mechanically sound material which economically meets the requirements for the majority of cable tray applications. Its superb strength-to-weight ratio, corrosion resistance, and high level of conductivity, make 6063 T6 aluminum an ideal material for a cable tray system.

Aluminum 3003 is utilized to fabricate Snap Track covers, accessories, and welded fittings.

The Snap Track patented pin is manufactured from alloy 6061 aluminum and contains a 302 stainless steel spring.

Although cable tray systems are NOT generally in direct contact with the process media, environmental conditions can exist, and process upsets can occur. Therefore, corrosion resistance of the Snap Track system is a design criterion.

Consideration must be given to the suitability of the aluminum alloys used in the Snap Track system. The alloys used in the Snap Track system do not respond in a similar manner in different corrosive environments. **Corrosion Chart A** is provided as a guide for **<u>sustained direct contact, NOT overall compatibility in atmospheric conditions</u>**. **Corrosion Chart B** is provided as a guide for considering galvanic corrosion. Ultimately the end user or designer must make the final decision as to the suitability of the Snap Track system, based on their knowledge of the various chemical elements which may affect the system.

In applications where aluminum alloys are not suitable, please contact TechLine Mfg. Alternative, bolted ventilated bottom channel tray systems are available in stainless steel and hot dipped galvanized.

Corrosion Chart A

A Excellent B Good C Fair D Unsatisfactory	SNAP TRACK Aluminum Alloys 6063 - T6,6003,6061						
Acetaldehyde	A		Acetic Acid	B		Acetic Anhydride	A
Acetic Acid	B		Acetone	B		Acetylene	A
Acrylonitrile	B		Alcohols	B		Aluminum Chloride	D
Aluminum Fluoride	A		Aluminum Hydroxide	B		Aluminum Sulfate	C
Amines	B		Ammonia Anhydrous	B		Amm. Bicarbonate	B
Amm. Carbonate	B		Ammonium Chloride	D		Ammonium Hydroxide	B
Amm. Monophosphate	B		Ammonium Nitrate	B		Ammonium Phosphate	A
Ammonium Sulfate	D		Ammonium Sulfite	D		Amyl Acetate	A
Aniline	B		Apple Juice	B		Arsenic Acid	D
Asphalt	A		Barium Carbonate	D		Barium Chloride	B
Barium Hydroxide	D		Barium Nitrate	B		Barium Sulfide	D
Beer	A		Beer Sugar Liquor	A		Benzene	B
Borax	C		Black Sulfate Liquor	D		Boric Acid	B
Bromine Dry	B		Bromine Wet	D		Bunker Oil	A
Buttermilk	A		Butyric Acid	B		Cal. Bisulphite	D
Cal. Carbonate	C		Cal. Chloride	B		Cal. Hydroxide	C
Cal. Hypochlorite	D		Calcium Sulfate	B		Carbolic Acid	B
Carbon Bisulfide	A		Carbon Dioxide	A		Carbonic Acid	A
Carbon Tet - Wet	D		Carbon Tet - Dry	A		Carbonated Water	A
Castor Oil	A		Chlorinated Solvent	A		Chloric Acid	D
Chlorinated Water	D		Chlorine Gas - Dry	D		Chlorine - Wet	D
Chloroform Dry	A		Chlorosulphonic - Dry	A		ChlorosulphonicWet	D
Chromic Aluminum	C		Chrome Acid	D		Citric Acid	B
Coconut Oil	A		Coke Oven Gas	A		Copper Acetate	D
Copper Chloride	D		Copper Nitrate	D		Copper Sulfate	D
Cotton Seed Oil	B		Crude Oil, Sweet	A		Diesel Fuel	A
Diethyl amine	B		Dowtherm	A		Drying Oil	C
Epsom Salt	A		Ethane	A		Ethyl Acetate	A

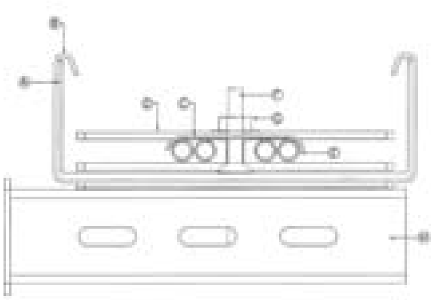
A Excellent B Good C Fair D Unsatisfactory	Aluminum Alloys 6063 - T6,6003,6061						
Ethyl Alcohol	B		Ethyl Chloride - Dry	B		Ethyl Chloride – Wet	B
Ethylene Glycol	A		Ethylene Oxide	A		Fatty Acid	A
Ferric Chloride	D		Ferric Nitrate	D		Ferric Sulfate	D
Ferrous Chloride	D		Ferrous Sulfate	C		Fish Oils	B
Fluorine - Dry	B		Fluorine – Wet	D		Fluroboric Acid	D
Fluorosilicate Acid	D		Formaldehyde Cold	A		Formaldehyde Hot	B
Formic Acid Cold	A		Formic Acid Hot	D		Freon	B
Furfural	B		Gasoline	A		Gas, Manufactured	B
Gas, Natural	A		Gas Odorizers	A		Glucose	A
Glue	A		Glycerine	A		Glycols	A
Grease	A		Heptane	A		Hexane	A
Hydraulic Oil	A		Hydro bromic Acid	D		Hydrochloric Acid	D
Hydrocyanic Acid	A		Hydrofluoric Acid	D		Hydrogen Gas - Cold	A
Hydrogen CL - Dry	D		Hydrogen CL – Wet	D		Hydrogen Peroxide –Dil.	A
Hydrogen Peroxide	A		Hydro Sulfide – Dry	B		Hydrogen Sulfide – Wet	B
Hydrofluosilic	D		Illuminating Gas	A		Ink	C
Iodine	D		Iodoform	A		Isooctane	A
Isopropyl Alcohol	B		Isopropyl Ether	A		JP - 4 Jet Fuel	A
JP - 5 Jet Fuel	A		JP - 6 Jet Fuel	A		Kerosene	A
Ketchup	A		Ketones	A		Lactic Acid	A
Lard Oil	A		Magnesium Bisulfate	A		Magnesium Chloride	B
Mag. Hydroxide	D		Magnesium Sulfate	A		Maleic Acid	B
Malic Acid	B		Mayonnaise	D		Melamine Resin	B
Mercuric Cyanide	D		Mercury	D		Methane	A
Methyl Acetate	B		Methyl Acetone	B		Methyl Alcohol	B
Methyl Chloride	D		Methylamine	B		Methyl Ethyl Ketone	A
Methylene Chloride	A		Milk	A		Mineral Oil	A
Molasses	A		Muriatic Acid	D		Mustard	D
Naphtha	A		Naphthalene	B		Natural Gas	A
Nickel Chloride	D		Nickel Nitrate	C		Nickel Sulfate	D
Nitric Acid All	D		Nitrobenzene	A		Nitrogen	A
Nitrous Acid 10%	D		Nitrous Oxide	C		Oils, Animals	A
Oleic Acid	B		Oleum	B		Olive Oil	A

A Excellent B Good C Fair D Unsatisfactory	Aluminum Alloys 6063 - T6,6003,6061		SNAP TRACK				
Oxalic Acid	C		Oxygen	A		Ozone – Dry	A
Ozone – Wet	A		Palmitic Acid	B		Paraffin	A
Paraformaldehyde	B		Pentane	A		Phenol	B
Phosphoric Acid 10%	A		Phosphoric Acid > 10%	D		Phthalic Acid	B
Phthalic Anhydride	A		Picric Acid	C		Pine Oil	A
Pineapple Juice	A		Potassium Bisulfite	B		Potassium Bromide	D
Potassium Carbonate	D		Potassium Chlorate	D		Potassium Chloride	D
Potassium Cyanide	D		Potassium Dichromate	A		Potassium Diphosphate	B
Potassium Ferricyanide	B		Potassium Ferro cyanide	A		Potassium Hydroxide	D
Potassium Hypochlorite	D		Potassium Permanganate	A		Potassium Sulfate	A
Potassium Sulfide	D		Propane	A		Propyl Alcohol	A
Pyrogallic Acid	B		Salad Oil	D		Salicylic Acid	B
Salt	A		Sea Water	B		Silver Bromide	D
Silver Chloride	D		Silver Nitrate	D		Sodium Acetate	A

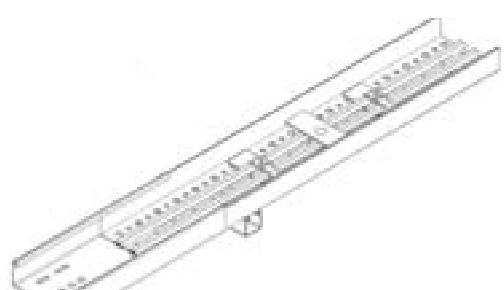
Galvanic Corrosion can occur if two dissimilar metals are electrically connected and exposed to an electrolyte. The more electro-chemically active metal corrodes by galvanic reaction at an increased rate. Galvanic corrosion potential (GCP) is a measure of how dissimilar metals may corrode when electrically connected and exposed to an electrolyte i.e., water. The farther apart any two metals are on the chart, the stronger the potential will be for a corroding effect on the higher one on the list. Conversely, the closer the two items are to one another, the smaller the GCP. Galvanic Corrosion Chart B simply represents the potential available to promote galvanic corrosion. The effect and the degree of actual corrosion are difficult to predict.

In applications or environments where galvanic corrosion is a concern, the designer may choose to:

- (a) Utilize an alternative support material
- (b) Electrically isolate any dissimilar metals
    - (1) This can easily be achieved through the use of an electrical isolator.



FRONT VIEW



ISOMETRIC VIEW

Isolator Pads

TechLine Mfg.'s isolator pad fits between strut supports and Snap Track, reducing dissimilar metal corrosion and protecting vital components.

Corrosion Chart B

Draw a line from the two metals which are being combined. The closer the center of the line is to zero, the lower the risk of galvanic corrosion.

Platinum - -		- - 34		-- Magnesium
Gold - -		- 32		-- Magnesium Alloys
Graphite - -		- - 30		-- Zinc
Silver - -		- - 28		-- Aluminum 1100300350526061 6063
Stainless 316 (Passive)- -		- - 26		-- Cadmium
Stainless 304 (Passive) - -		- - 24		-- Aluminum Clad
Stainless 400 (Passive) - -	PROTECTED (CATHODIC)	- - 22	CORRODED (ANODIC)	-- Steel or Iron
Inconel (Passive) - -		- - 20		-- Cast Iron
Nickel (Passive) - -		- - 18		-- Stainless 400 (Active)
Silver Solder - -		- - 16		-- Ni Resist
Monel - -		- - 14		-- Stainless 304 (Active)
Copper Nickel Alloys - -		- - 12		-- Stainless 316 (Active)
Bronzes - -		- - 10		-- Hastelloy C
Copper - -		- 8		-- Lead-In Solders
Brasses - -		- 6		-- Lead
Hastelloy B - -		- 4		-- Tin
Hastelloy A - -		- 2		-- Nickel (Active)
Inconel (Active) - -		0 - 0		-- Inconel (Active)
Nickel (Active) - -		2 - -		-- Hastelloy A
Tin - -		4 - -		-- Hastelloy B
Lead - -		6 - -		-- Brasses
LeanIn Solders - -		8 - -		-- Copper
Hastelloy C - -		10 - -		-- Bronzes
Stainless 316 (Active) - -		12 - -		-- Copper Nickel Alloys-
Stainless 304 (Active) - -		14 - -		-- Monel
Ni Resist - -	CORRODED (ANODIC)	16 - -	PROTECTED (CATHODIC)	-- Silver Solder
Stainless 400 (Active) - -		18 - -		-- Nickel (Passive)
Cast Iron - -		20 - -		-- Inconel (Passive)
Steel or Iron - -		22 - -		-- Stainless 400 (Passive)
Aluminum Clad - -		24 - -		-- Stainless 304 (Passive)
Cadmium - -		26 - -		-- Stainless 316 (Passive)
1100300350526061 6063 - -		28 - -		-- Silver
Zinc - -		30 - -		-- Graphite
Magnesium Alloys - -		32 - -		-- Gold
Magnesium - -		34 - -		-- Platinum

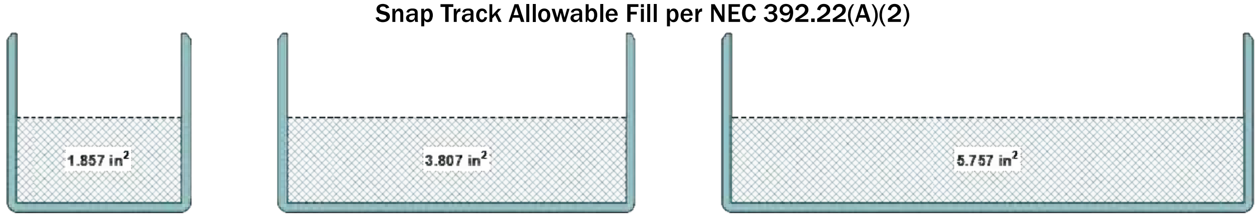
The above information is provided for guidance only.

Channel Size and Fill Capacity

Snap Track channel tray is manufactured in nominal widths of 2”, 4”, and 6” and a nominal depth of 2”. The appropriate size and number of channels depends on the number and size of the conductors required, and the allowable fill area specified in the guidance provided by NEC. Consideration should also be given to EMI effects. Because the Snap Track system uniquely offers flexibility for expansion and changes, engineers and designers should design and size systems to anticipate both current and future needs.

Permitted Fill Capacity per NEC

Snap Track Allowable Fill per NEC 392.22(A)(2)



392.20 Cable and Conductor Installation

(A) Multiconductor Cables Operating at 1000 Volts or Less. Multiconductor cables operating at 1000 volts or less shall be permitted to be installed in the same tray.

(B) Cables Operating at Over 1000 Volts. Cables operating at over 1000 volts and those operating at 1000 volts or less installed in the same cable tray shall comply with either of the following:

(1) The cables operating at over 1000 volts are Type MC.

(2) The cables operating at over 1000 volts are separated from the cables operating at 1000 volts or less by a solid fixed barrier of a material compatible with the cable tray.

(C) Connected in Parallel. Where single conductor cables comprising each phase, neutral, or grounded conductor of an alternating current circuit are connected in parallel as permitted in 310.10(H), the conductors shall be installed in groups consisting of not more than one conductor per phase, neutral, or grounded conductor to prevent current imbalance in the paralleled conductors due to inductive reactance. Single conductors shall be securely bound in circuit groups to prevent excessive movement due to fault-current magnetic forces unless single conductors are cabled together, such as triplexed assemblies.

(D) Single Conductors. Where any of the single conductors installed in ladder or ventilated trough cable trays are 1/0 through 4/0 AWG, all single conductors shall be installed in a single layer. Conductors that are bound together to comprise each circuit group shall be permitted to be installed in other than a single layer.

392.22 Number of Conductors or Cables

(A) Number of Multiconductor Cables, Rated 2000 Volts or Less, in Cable Trays. The number of multiconductor cables, rated 2000 volts or less, permitted in a single cable tray shall not exceed the requirements of this section. The conductor sizes shall apply to both aluminum and copper conductors. Where dividers are used, fill calculations shall apply to each divided section of the cable tray.

(1) Ladder or Ventilated Trough Cable Trays Containing Any Mixture of Cables. Where ladder or ventilated trough cable trays contain multiconductor power or lighting cables, or any mixture of multiconductor power, lighting, control, and signal cables, the maximum number of cables shall conform to the following:

(a) Where all of the cables are 4/0 AWG or larger, the sum of the diameters of all cables shall not exceed the cable tray width, and the cables shall be installed in a single layer. Where the cable ampacity is determined according to 392.80(A)(1)(c), the cable tray width shall not be less than the sum of the diameters of the cables and the sum of the required spacing widths between the cables.

(b) Where all of the cables are smaller than 4/0 AWG, the sum of the cross-sectional areas of all cables shall not exceed the maximum allowable cable fill area in Column 1 of Table 392.22(A) for the appropriate cable tray width.

(c) Where 4/0 AWG or larger cables are installed in the same cable tray with cables smaller than 4/0 AWG, the sum of the crosssectional areas of all cables smaller than 4/0 AWG shall not exceed the maximum allowable fill area resulting from the calculation in Column 2 of Table 392.22(A) for the appropriate cable tray width. The 4/0 AWG and larger cables shall be installed in a single layer, and no other cables shall be placed on them.

(2) Ladder or Ventilated Trough Cable Trays Containing Multiconductor Control and/or Signal Cables Only. Where a ladder or ventilated trough cable tray having a usable inside depth of 150 mm (6 in.) or less contains multiconductor control and/or signal cables only, the sum of the crosssectional areas of all cables at any cross section shall not exceed 50 percent of the interior crosssectional area of the cable tray. A depth of 150 mm (6 in.) shall be used to calculate the allowable interior crosssectional area of any cable tray that has a usable inside depth of more than 150 mm (6 in.).

(5) Ventilated Channel Cable Trays Containing Multiconductor Cables of Any Type. Where ventilated channel cable trays contain multiconductor cables of any type, the following shall apply:

(a) Where only one multiconductor cable is installed, the crosssectional area shall not exceed the value specified in Column 1 of Table 392.22(A)(5).

(b) Where more than one multiconductor cable is installed, the sum of the crosssectional area of all cables shall not exceed the value specified in Column 2 of Table 392.22(A)(5).

(B) Number of Single Conductor Cables, Rated 2000 Volts or Less, in Cable Tray. The number of single conductor cables, rated 2000 volts or less, permitted in a single cable tray section shall not exceed the requirements of this section. The single conductors, or conductor assemblies, shall be evenly distributed across the cable tray. The conductor sizes shall apply to both aluminum and copper conductors.

(1) Ladder or Ventilated Trough Cable Trays. Where ladder or ventilated trough cable trays contain singleconductor cables, the maximum number of single conductors shall conform to the following:

(a) Where all of the cables are 1000 kcmil or larger, the sum of the diameters of all singleconductor cables shall not exceed the cable tray width, and the cables shall be installed in a single layer. Conductors that are bound together to comprise each circuit group shall be permitted to be installed in

other than a single layer.
(b) Where all of the cables are from 250 kcmil through 900 kcmil, the sum of the crosssectional areas of all single conductor cables shall not exceed the maximum allowable cable fill area in Column 1 of Table 392.22(B)(1) for the appropriate cable tray width.
(c) Where 1000 kcmil or larger singleconductor cables are installed in the same cable tray with single conductor cables smaller than 1000 kcmil, the sum of the crosssectional areas of all cables smaller than 1000 kcmil shall not exceed the maximum allowable fill area resulting from the computation in Column 2 of Table 392.22(B)(1) for the appropriate cable tray width.
(d) Where any of the single conductor cables are 1/0 through 4/0 AWG, the sum of the diameters of all single conductor cables shall not exceed the cable tray width.

(2) Ventilated Channel Cable Trays. Where 50 mm (2 in.), 75 mm (3 in.), 10mm (4 in.), or 150mm (6 in.) wide ventilated channel cable trays contain single conductor cables, the sum of the diameters of all single conductors shall not exceed the inside width of the channel.

Table 392.22 (A)(5)

Allowable Cable Fill Area for Multiconductor Cables in Ventilated Channel Cable Trays for Cables Rated 2000 Volts or Less

Inside Width of Cable Tray		Column 1 One Cable		Column 2 More Than One Cable	
mm	in	mm 2	in2	mm 2	in2
50	2	900	1.4	580	0.9
75	3	1500	2.3	850	1.3
100	4	2900	4.5	1600	2.5
150	6	4500	7.0	2450	3.8

§ TechLine Mfg. recommends the guidelines set forth in NEC Table 392.22 (A (5), for multi-conductor cables when considering the fill capacity of Snap Track 4" and 6" width channels. However, note that the NEC Table 392.22 (A)(5) does not provide guidance for multi-conductor cables in two inch 2" width trays. The data provided for 2" width trays is interpolated from available information in NEC Table 392.22(A)(5) and NEC Table 392.22(A)(6).

Table 392.22 (A)

Allowable Cable Fill Area for Multi-Conductor Cables in Ladder, Ventilated Trough for Cables Rated 2000 Volts or Less

Inside Width of Cable Tray		Column 1 Applicable for 392.22(A)(1)(b) Only		Column 2a Applicable for 392.22(A)(1)(c) Only	
mm	in	mm 2	in2	mm 2	in2
50	2	1500	2.5	1500 – (30 Sd)b	2.5 – (1.2 Sd)b
100	4	3000	4.5	3000 – (30 Sd)b	4.5 – (1.2 Sd)b
150	6	4500	7.0	4500 – (30 Sd)b	7 – (1.2 Sd)b

[a] The maximum allowable fill areas in Columns 2 and 4 shall be calculated. For example, the maximum allowable fill in mm2 for a 150-mm wide cable tray in Column 2 shall be 4500 minus (30 multiplied by Sd) [the maximum allowable fill, in square inches, for a 6-in. wide cable tray in Column 2 shall be 7 minus (1.2 multiplied by Sd)].

[b] The term Sd in Columns 2 is equal to the sum of the diameters, in mm, of all cables 107.2 mm2 (in inches, of all 4/0 AWG) and larger multiconductor cables in the same cable tray with smaller cables.

Table 392.22(B)(1)

Allowable Cable Fill Area for Single Conductor Cables in Ladder, Ventilated Trough, or Wire Mesh Cable Trays for Cables Rated 2000 Volts or Less

Inside Width of Cable Tray		Column 1 Applicable for 392.22(B)(1)(b) Only		Column 2a Applicable for 392.22(B)(1)(c) Only	
mm	in	mm 2	in2	mm 2	in2
50	2	1400	2.0	1400 – (28 Sd)b	2.0 – (1.1 Sd)b
100	4	2800	4.5	2800 – (28 Sd)b	4.5 – (1.1 Sd)b
150	6	4200	6.5	4200 – (28 Sd)b	6.5 – (1.1 Sd)b

Ampacity and Conductors

The allowable ampacity (current-carrying rating) of conductors and cables, nominally rated 2000 volts or less, installed in Snap Track trays should be in accordance with NEC sections 392.22 (A) and 392.22 (B), and as outlined in NEC section 392.80 - Ampacity of Conductors. Designers and engineers should refer to the applicable tables mentioned in section 392.80 and note the adjustment factors, for non-ventilated covers, listed in sections 392.80(A)(1) (a)(c) and 392.80 (A)(2) (a)–(d). Further attention should be paid to the spacing requirements and ambient temperature limitations in these sections.

CAUTION:

The NEC requirements for channel tray fill in section 392.22 and the ampacity rating of cables in section 392.80 addresses the heat build-up in conductors while current is flowing. Failure to follow these guidelines when installing any cable tray system can result in systems that are overloaded and cause excessive heat buildup. When excessive heat builds up in and around live conductors, the insulation can breakdown and create potential shock hazards or fires. Fires can occur in channel trays (which provide a fire path) or in combustible materials near the channel tray.

Fittings Use

Utilization of Snap Track Fittings:

The Snap Track system is designed and intended to be used as a **UL Classified continuous assembly of straight sections, fittings, and accessories used to form a structural support** for the purpose of supporting, **protecting**, and securely fastening cables. When installed in a continuous manner, the entire Snap Track system is UL classified as an equipment ground conductor (EGC). TechLine Mfg. has gone to great lengths to provide numerous variations of fittings, both common and unique, in an effort to facilitate this design criterion. Engineers and designers are encouraged to refer to the most current Snap Track catalog for a full understanding and selection of the fittings available.

Where discontinuous sections are necessary, or should the engineer or designer choose to not fully utilize the available Snap Track fittings, the **discontinuous sections should be installed per NEC section 392.30 Securing and Supporting, paragraph (B) (3).**

The system shall provide for the support of cables and raceway wiring methods in accordance with their corresponding articles. Where cable trays support individual conductors and where the **conductors pass from one cable tray to another**, or from cable tray to raceway(s) or from cable tray to equipment where the conductors are terminated, **the distance between the cable trays** or between the cable tray and the raceway(s) or the equipment **shall not exceed 1.8 m (6 ft.). The conductors shall be secured to the cable tray(s) at the transition, and shall be protected, by guarding or by location, from physical damage.**
Further, it should be noted that bonding jumpers are required to electrically connect all discontinuous sections per NEC section 392.18 (A) COMPLETE SYSTEM. **See Bonding page 37 for further details.**

Cable trays shall be installed as a complete system. **Field bends or modifications shall be so made that the electrical continuity of the cable tray system and support for the cables is maintained.** ***Cable tray systems shall be permitted to have mechanically discontinuous segments between cable runs or between cable tray runs and equipment.***

TechLine Mfg. designed Snap Track to effectively route, support, and PROTECT the installed cables. Therefore, TechLine Mfg. recommends that engineers and designers consider systems which minimize mechanically disconnected sections. Mechanically disconnected sections are permissible under NEC when installed per the applicable codes. However, TechLine Mfg. recommends mechanically disconnected sections be limited to awkward transitions where Snap Track fittings are not available.

Additional limitations and or allowance may apply based on the cable type installed in the UL Classified Snap Track tray system. Engineers and designers are encouraged to fully review the NEC Articles associated to the cables used in their application.

Thermal Expansion

When installing a continuous metallic cable tray system the thermal expansion of the individual sections should be considered. **For these considerations TechLine Mfg. recommends the guidance found in NEMA BI50016, Section 3.4.2.**

NEMA BI50016, SECTION 3.4.2

It is important that expansion and contraction be considered when installing cable trays. The length of straight section tray run and the temperature differential govern the number of thermal expansion splice plates required.

Table 01—Maximum Spacing between Expansion Joints that Provide for 25.4 mm (1 in) Movement**

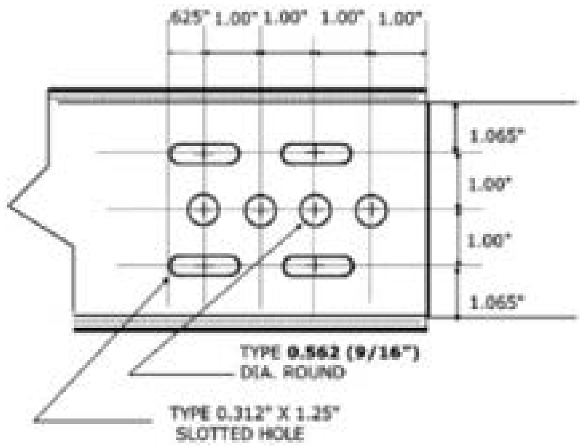
Temperature Differential*		Steel		Aluminum		Fiberglass	
°C	(°F)	m	(ft)	m	(ft)	m	(ft)
14	(25)	156	(512)	79	(260)	203	(667)
28	(50)	78	(256)	40	(130)	102	(333)
42	(75)	52	(171)	27	(87)	68	(222)
56	(100)	39	(128)	20	(65)	51	(167)
70	(125)	31	(102)	16	(52)	41	(133)
83	(150)	26	(85)	13	(43)	34	(111)
97	(175)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

It is important that expansion and contraction be considered when installing cable trays. The length of straight section tray run, and the temperature differential govern the number of thermal expansion splice plates required.

In the majority of applications, TechLine Mfg. recommends Thermal Expansion joints be placed every 20m (65 ft.). In environments where the differential temperatures (the difference between minimum ambient temperature and maximum ambient temperature in an area) will exceed 56 degree C (100degree F), refer to the NEMA Table 4-2 for appropriate spacing.

<u>All</u> Snap Track splices and fittings are manufactured with four (4) 5/16” x 1.25” (.34 cm x 3.17 cm) oval slots, making all Snap Track splices and fittings suitable for use as an expansion splice.



The 1.25 in (3.17cm) oval slot provided in ALL Snap Track splices and ALL Snap Track fittings represents 125% of the maximum gap areas outlined in NEMA BI50016 Figure 3.45. Consequently, considerations for gap calculations in the NEMA BI50016 Figure 3.45 are unnecessary when designing and installing the Snap Track system.

The purpose of Snap Track expansion splice plate (or Snap Track fittings when used as expansion splice plates) is to allow longitudinal movement in a secured and supported section, as thermal expansion occurs. **To provide adequate longitudinal movement when installing Snap Track thermal expansion splices, TechLine Mfg. recommends the guidance provided in NEMA BI50016 Section 4.13A Hold Down and Clamp Guide Locations.**

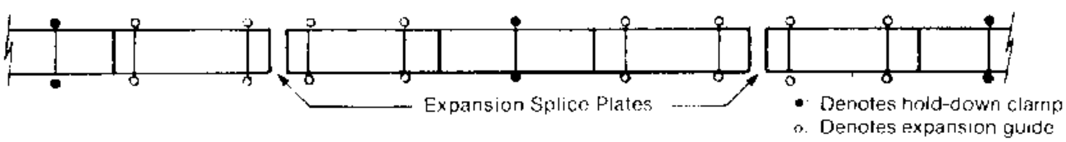


Figure 044—Hold Down and Guide Clamp Locations

The tray should be anchored with hold down clamps or with a fixed support nearest the midpoint between expansion plates and secured with expansion guides at all other support locations.

Understanding Load

This section presents guidelines for design considerations with respect to weather factors, methods of load determination, maximum allowable working stresses and other considerations. This information is provided in an effort to assist engineers, designers, and installers in the design of support systems for the Snap Track system, which will achieve the desired strength results at the most economical installed cost.

Load can be classified into three types:

1. Dead Loads (Static) - Do not change the magnitude or their position during the life of the structure. A summing of the weight of the individual parts is all that is required to determine the dead load.

2. Live Loads - potential changes in magnitude, position and/or their direction during the life of the structure.

3. Dynamic Loads (Parasitic) - ice, snow, wind and traction (seismic), or caused by the motion of the live load, or the movement of the structure.

Determination of Design Loadings

When determining the total load requirements for the Snap Track system, engineers or designers should not only consider the total dead load but also the additional loads which may be produced by ice, wind, snow, or seismic conditions.

The following calculation may be used in most applications. In areas where there are special wind considerations (hurricane zones) or in seismic zones, additional calculations and considerations should be made:

$$W_{total} = W_{ctotal} + W_{snic} + W_{ct}$$

W_{total} = Total load

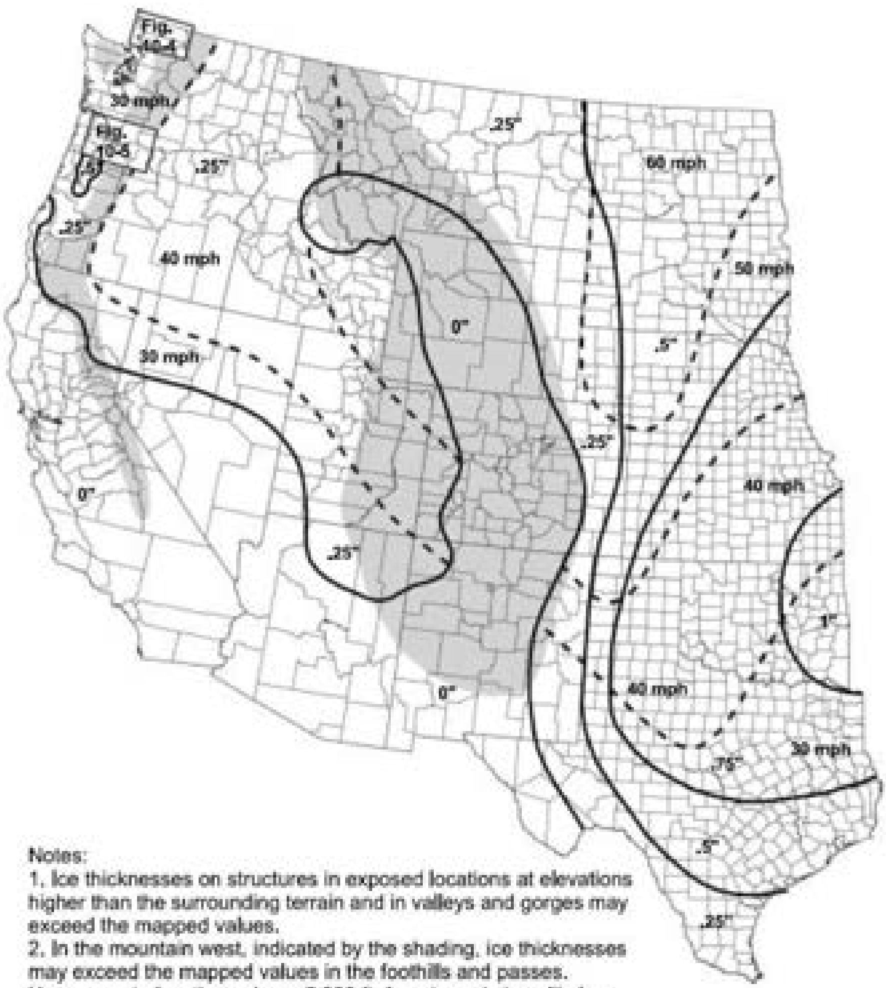
W_{ctotal} = Total weight of cable tray accessories

W_{snic} = Total weight of snow and ice

W_{ct} = Total cable weight

Ice Loads

Snow and ice load calculations are especially important when the tray is covered. Snow and ice load calculations are area dependent. TechLine Mfg. recommends that engineers and designers review historical local snow and ice accumulation levels to determine these dynamic loads. American Society of Civil Engineering Article ASCE-7 provides guidance in determining ice load factors by area.



Notes:
1. Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.
2. In the mountain west, indicated by the shading, ice thicknesses may exceed the mapped values in the foothills and passes. However, at elevations above 5,000 ft, freezing rain is unlikely.
3. In the Appalachian Mountains, indicated by the shading, ice thicknesses may vary significantly over short distances.

FIGURE 10-2 50-YEAR MEAN RECURRENCE INTERVAL UNIFORM ICE THICKNESSES DUE TO FREEZING RAIN WITH CONCURRENT 3-SECOND GUST SPEEDS: CONTIGUOUS 48 STATES.

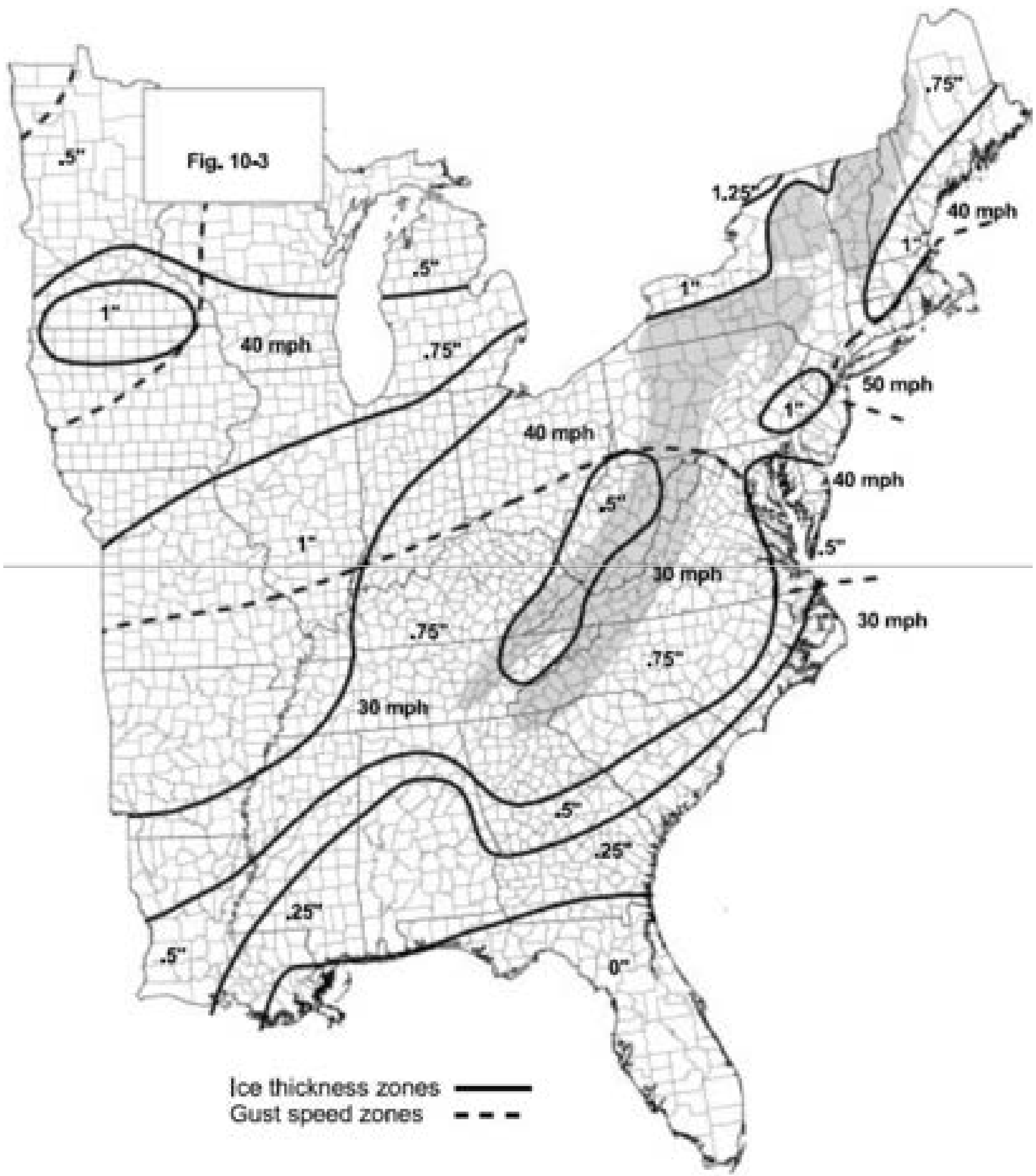


FIGURE 10-2 (continued) 50-YEAR MEAN RECURRENCE INTERVAL UNIFORM ICE THICKNESSES DUE TO FREEZING RAIN WITH CONCURRENT 3-SECOND GUST SPEEDS: CONTIGUOUS 48 STATES.

Ice loads are generally caused by rain or drizzle freezing on impact and generally occur on the top surface (or cover) and the windward side of the cable tray system. The additional design load to be added due to ice can be calculated as follows:

$$LI = \left(\frac{W \times TI}{240} \right) X\ DI$$ where:

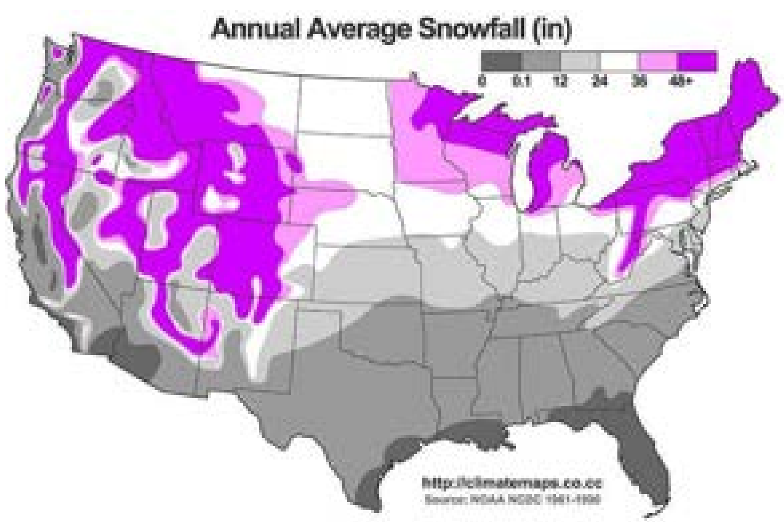
LI = Ice Load (lbs. / linear foot)
W= Cable Tray Width (inches)
TI = Maximum Ice Thickness
DI= Ice Density = 57 lbs. /cu. Ft.

The ASCE-7 maps indicate average ice thickness between ¼” and 1”. The following table reflects the resulting load for 2”-6” Snap Track tray.

Ice Load Table

ICE Thickness	Tray Size		
	2”	4”	6”
0.25 in.	0.12 lbs. / ft.	0.23 lbs. / ft.	0.35 lbs. / ft.
0.50 in.	0.24 lbs. / ft.	0.47 lbs. / ft.	0.71 lbs. / ft.
0.75 in.	0.35 lbs. /ft.	0.71 lbs. / ft.	1.07 lbs. / ft.
1.00 in.	0.47 lbs. / ft.	0.95 lbs. / ft.	1.42 lbs. / ft.

Snow Loads
As with ice, additional potential loads from snow should also be considered in areas with heavy to moderate annual snow falls. The following map outlines these areas as noted by NOAA.



The density of snow widely varies. New dry snow can have densities as low as 8% of water while heavily packed snow can reach densities of 50% of water by late spring. Considering the mean being 30%, we have used a density of 18.72 lbs. / cu. ft. when calculating potential snow loads. All Snap Track trays 2”-6” are manufactured with two inch (2”) solid side rails.

Considering the 2” depth and the maximum width of 6” an accumulation depth of 2” is sufficient regardless of whether the tray is covered. Given these criteria and using the same formula as used for ice loads, TechLine Mfg. recommends the following Snow Loads be used whenever Snap Track tray is installed in potential snow areas.

Snow Load Table

Snow Depth	Tray Size		
	2”	4”	6”
2”	0.31 lbs. / ft.	0.62 lbs. ft.	0.94 lbs. ft.

Wind Loads

ASCE 7-10 also provides assistance in determining wind load factors for the Snap Track system. Note that ASCE 7-10 has revised the hurricane prone zone. When in the hurricane prone zone or special wind regions, TechLine Mfg. recommends that the impact of wind force be considered.

The effect of wind force on the Snap Track system will vary based upon the tray orientation. Unlike ladder tray where the largest exposed surface area is the side wall, the largest surface area for Snap Track will be a 6” covered tray in the vertical position.

Note: *Wind loads are a different dynamic force than the loads created by tray accessories, cable, snow and ice. Therefore, wind loads SHOULD NOT be added to the total load calculation. As with other cable trays, consideration of wind loading is used to determine maximum supports span distances and methods for securing covers.*

To determine ***wind loads***, the designer must first establish the area of the Snap Track tray. To determine the total area the formula is:

Area Calculation:

Width X Length or distance of tray.

60 ft. of 6” tray = 4320in^2 = 30ft^2

With the area determined, the wind force or impact pressure can be determined as follows: Wind Force Calculation

Formula Used: F = A* (Ce* Cq *Qs)

Where:

F=

Force

A= Area

Ce= Elevation Factor (0 - 15’ used)

Cq= Unified Building Code Factor (1.3 Exposure area B)

Qs= Wind Speed factor

The results for a 60 ft. run of 6” tray with a 75 mph wind would be:

RESULTS

FORMULA: F = A * (Ce * Cq * Qs)

USED:

SQ FT: 30 sq. ft.

WIND: 26.021 lbs. per sq. ft.

PRESSURE:

TOTAL FORCE: 780.62 lbs.

ELEMENTS:

- Ce = 1.39
- Cq = 1.3
- Qs = 14.4

Note: *wind force calculation based on Uniform Building Code UBC Exposure area B, an of elevation 0 - 15’, and 60ft.of vertical covered 6” tray are used.*

*(*Exposure B has terrain with buildings, forest or surface irregularities, covering at least 20 percent of the ground level area extending 1 mile (1.61 km) or more from the site.)

The wind load on Snap Track tray is calculated as follows:

$$WL = \frac{P \times W}{12}$$

Where:

WL = Wind Load
P= Wind Pressure
W = Width

Using these calculations, the following values are provided for 6" tray to assist designers in determining wind load effects on Snap Track tray.

Wind Speed (mph)	Resulting		
	Total Force	Wind Pressure	Lbs. / Ft.
75	48.16 lbs.	26.02 lbs./ Sq. Ft.	13.01 lbs./ Ft.
110	1,679.20 lbs.	55.97 lbs. / Sq. Ft.	27.98 lbs. / Ft.
129	2,309.39 lbs.	76.98 lbs. / Sq. Ft.	38.49 lbs. / Ft.
156	3,377.29 lbs.	112.57 lbs. / Sq. Ft.	56.28 lbs. / Ft.

TechLine Mfg. recommends considering wind loading effects ONLY when designing support systems in hurricane prone zones. When designing for hurricane prone zones TechLine recommends the following maximum support spans regardless of tray widths or orientation.

Saffir-Simpson Scale Category	Wind Speed	Maximum Support Spans
1	74 - 95 mph	10 ft.
2	96 - 110 mph	8 ft.
3	111 - 129 mph	6 ft.
4	130 - 156 mph	6 ft.

If Snap Track tray is installed outdoors with covers, another wind factor to be considered is the aerodynamic effect, which can produce a lift sufficient to separate the cover from the tray. Similar to an airplane wing the wind moving across a covered tray creates a positive pressure inside the tray and negative pressure above the cover. **See the Accessory section (page 51) of this manual for cover clamp recommendations for Snap Track covers in areas with strong wind.**

Seismic

As with ice, snow and wind, designers and engineers should consider potential seismic dynamic loads in earthquake-prone zones. These seismic or shearing forces are dependent on earthquake intensity, soil conditions, and the rigidity of the structure. Based on the number of variables and the multiple calculations required, **TechLine Mfg. recommends designers and engineers also refer to ASCE 7 for calculating seismic force when considering installations in potential seismic zones.**

Engineers and designers should note that a great deal of seismic testing of cable tray systems, and their supports, has been performed. The conclusion reached from these evaluations is that cable tray is generally stronger laterally than vertically, since it acts as a truss in the lateral direction.

When considering seismic effects, it should also be noted that the concern is not the tray system but rather the support system. In many seismic applications the support system requires additional bracing. **When seismic bracing is required for the Snap Track system, it should be applied to the supports and NOT the Snap Track tray system.**

TechLine Mfg. designs cable tray systems and recommends support spans on the basis of maximum allowable stress for the segments of tray under IEC61537. Therefore, the allowable loads will vary with span and width of tray. TechLine Mfg. provides Snap Track design loads based on the capability of the system under total load conditions, wind loads, span lengths, and resulting deflection. The resulting load data should be used to design the standards for support structures that result in the strength, stability, and deflection desired BASED ON THE TOTAL LOAD and Wind LOAD. **IF** IN A HURRICANE ZONE, wind load should be considered independently.

The suitability of the Snap Track system, for use under the additional loads applied by ice, snow, wind, or seismic conditions, is not limited by the Snap Track system but rather the by the adequate design of the support structure. It is the support system that supports the load, NOT the Snap Track Tray system.

Snap Track Load Data

Ventilated Bottom Channel Trays not exceeding 150 mm (6 in) in width and 50 mm (2 in) in depth currently do NOT have standardized tray loading requirements measured by the National Electrical Manufacturers Association's (NEMA) 50015 Section 4.8.3. TechLine deems traditional load information as an important factor for engineers, designers and other end users. Therefore, TechLine Mfg. has tested and published load data using the guidelines and standards set forth under IEC 61537.

IEC 61357 states that a safe working load is the load applied when the deflection equals the span divided by 100 i.e. a 10-foot span would be allowed 1.2 (in) 30.48 (mm) of deflection. The values in the Snap Track load table were obtained by using the procedure listed in NEMA 50015 Section 5.2 and the basis permitted under IEC 61357.

Snap Track Loading Information

Note: *Do not confuse span with tray length. The distance between supports is called SPAN.*

Span (feet)															
Tray		6'		8'		10'		12'		14'		16'		18'	
W	H	Load	Deft	Load	Deft	Load	Deft	Load	Deft	Load	Deft	Load	Deft	Load	Deft
2"	2"	70.93 lbs./ft	0.72 In.	25.15 lbs./ft	0.96 In.	11.7 lb/ft	1.2 In	6.1 lb/ft	1.44 In	3.5 lb/ft	1.68 In	2.5 lb/ft	1.92 In	1.3 lb/ft	2.16 in
4"	2"	67.12 lbs./ft	*0.63 In.*	31.4 lbs./ft	0.96 In.	13.7 lb/ft	1.2 In	7.3 lb/ft	1.44 In	4.2 lb/ft	1.68 In	3.4 lb/ft	1.92 In	2.5 lb/ft	2.16 in
6"	2"	73.19 lbs/ft	*0.63 In.*	34.21 lbs/ft	*0.80 In.*	17.7 lb/ft	1.2 In	9.7 lb/ft	1.44 In	9.7 lb/ft	1.68 In	3.8 lb/ft	1.92 In	2.1 lb/ft	2.16 in

*The listed load did not the reach maximum allowed deflection under IEC 61357.
Additonal flat bar could not be safely stacked due to height.

Informational Note: *Typical Foundation Fieldbus cable with a spiral wound armor (SWA) cable = 0.06 lbs. /ft.*

Supports

The design loads listed in the Snap Track load specification table should be used for designing the supports system and span distances.

Supports for the Snap Track system should be designed to provide strength and working load capabilities sufficient to meet the Total Load requirement. The total load requirement includes total cable weight, tray accessories, covers, as well as outdoor factors that the system will be subject to (i.e. wind, snow and iceloads).

When considering support systems, designers should also consider deflection. Deflection is the vertical sag of the tray at its midpoint and is at right angles to the trays longitudinal axis.

Concerns with deflection generally are with the resulting appearance. Consequently, rigid restrictions on the deflection of channel trays installed at eye level or in prominent locations are common. However, it is neither economical nor good engineering practice to restrict the deflection of a channel tray system in less prominent areas.

In many applications (total loads < 3 lbs. / ft.) a 14'-18' span distance is possible with the Snap Track system. Engineers and designers are encouraged to reconsider any existing support span specifications when designing for the Snap track system. Significant cost savings can result.

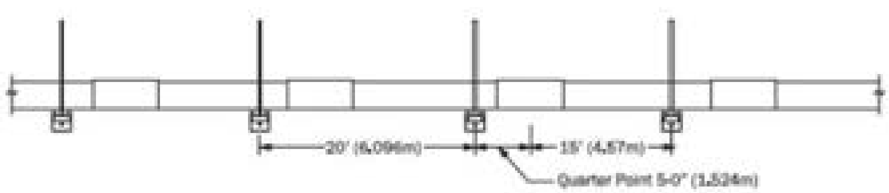
Note: *In all outdoor applications, the total load requirement should be calculated and compared to the Snap Track Load Data table to determine the appropriate support spans for straight horizontal runs.*

(A) Horizontal Straight Sections Supports should be located so that connectors (splice joints) fall between the support points and the quarter point of the span. The support span should never be greater than the 20'.

(1) The following example depicts the correct horizontal support locations when the total load is within the limits listed in the Snap Track Load Table for 18' spans. In ALL cases the total load should be calculated and compared to the Load Table to deter mine the appropriate span distance.

(B) Vertical Straight Sections

(1) Vertical straight sections should be supported at intervals dictated by the building structure. Not exceeding 20' centers.

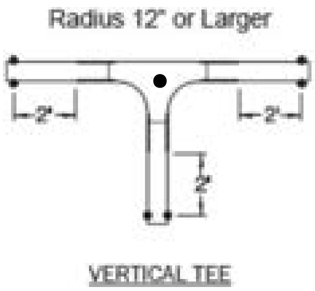


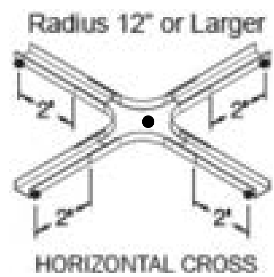
(C) Fittings

(1) Large Radius fittings - 12”r 36”r

TechLine recommends that Snap Track large radii fittings be supported per the guidelines set forth in NEMA BI-50016 section 3.5

a) Snap Track fittings installed in the verticalposition and all 12”r fittings should be supported within 2’ of each extremity. Expansion connections should also be supported within 2’ of each end.





b) When installed in the horizontal position, Snap Track 24”r, 36”r and larger fittings should be supported within 2’ of each extremity and include an addi tional center support.

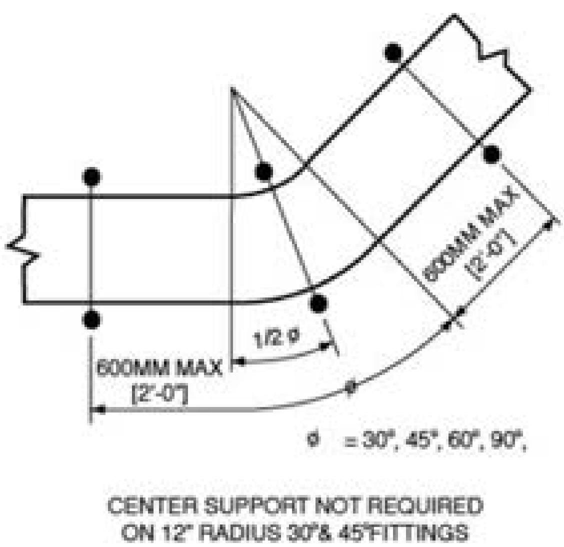


Figure 3-59 -- Horizontal Elbows

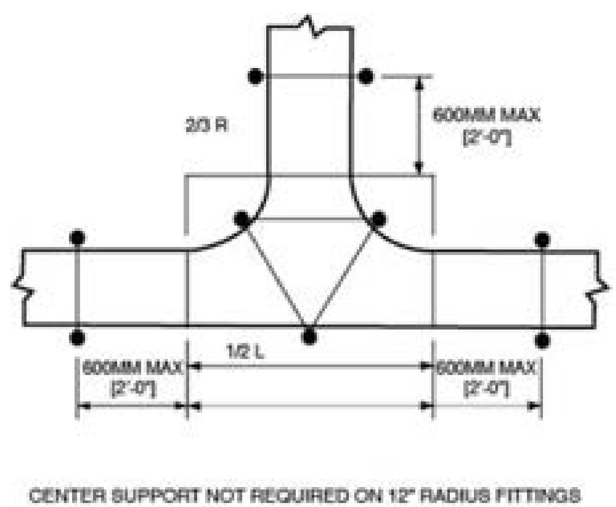
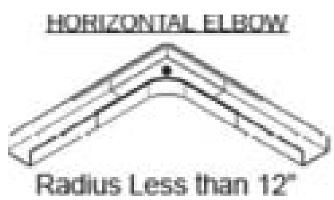


Figure 3-60 -- Horizontal Tee

(2) Short Radius Fittings < 12”r Snap Track fittings with a radius of 3” or 6” may be supported with a single center support.



Note: *The guidelines in NEMA 50016 are intended to address fittings with radii of 12” or larger. Snap Track uniquely offers smaller radius fittings typically for communication or control cables, which have a smaller bend radius. After extensive testing it was confirmed that for these smaller radii fittings a single center support will provide the same load bearing capacity as two supports located at each extremity. This recommendation is in accordance with NEMA 50016 Section 3.5.1- recommended support locations follow,* ***unless otherwise recommended by the manufacturer.***

When the installed span distance are within the load limits listed in the Snap Track Load Data Table, and the above recommendations are followed, the resulting deflection will be in accordance with IEC61357 (safe working loads recommendations).

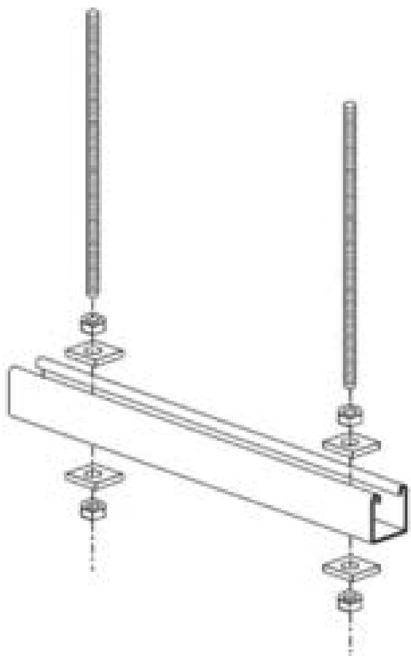
Designers and inspectors should note that the unique strength and rigidity of the Snap Track systems allows TechLine Mfg. to recommend a single center support for short radius fittings. This recommendation can result in significant cost reductions for the support system.

In extreme load applications, engineers and designers may also choose to support short radius fittings within 2' of each extremity.

Seismic considerations will affect the design of the cable tray support system. When considering seismic conditions, the supports should be braced according to the affecting seismic zone. Contact TechLine Mfg. for approved bracing information.

TechLine Mfg. offers numerous types of supports or brackets for the Snap Track system. This manual covers the more common ones. Engineers and designers are encouraged to refer to the most current Snap Track catalog for a full understanding and selection of the supports available through TechLine Mfg.; many of which were designed specifically for Snap Track.

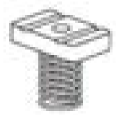
Trapeze and Hanger Brackets



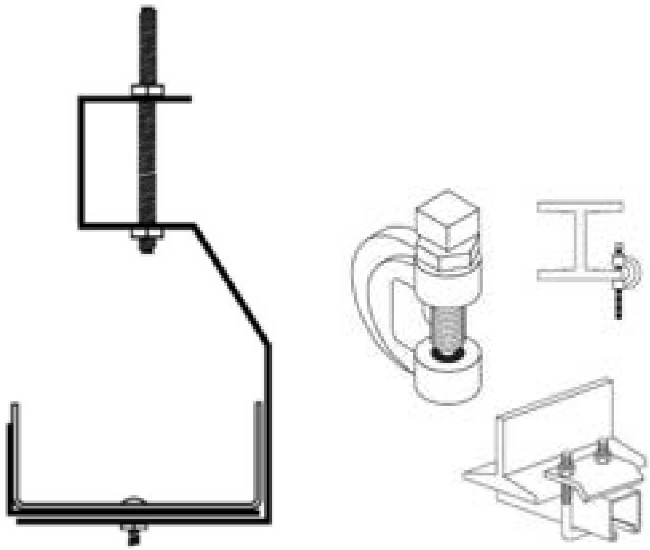
Trapeze or swing supports are the most common type. The support consists of:

(2) 3/8" threaded rods
(1) 1 5/8" strut
(4) Square washers
(4) 3/8" nuts

Strut spring nuts or Snap Track hold down clamps are also typically used.

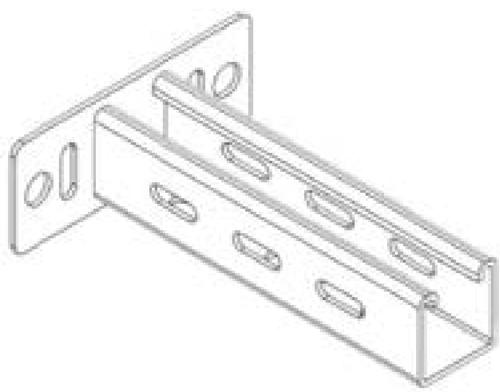


Hanger Bracket



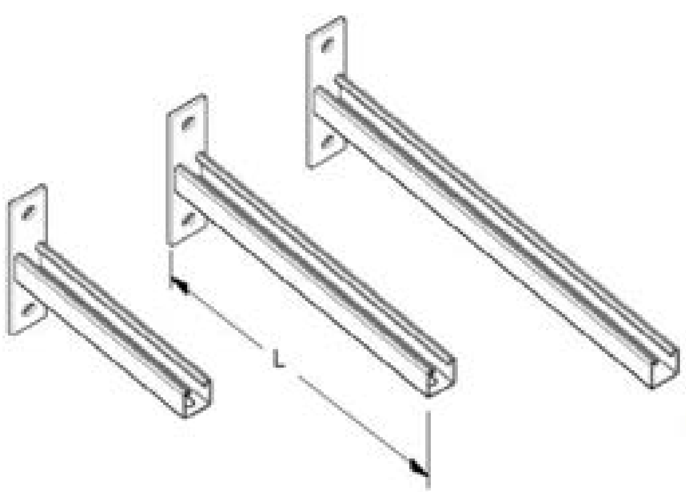
Hanger brackets are used for overhead or beam mounting with a beam clamp. Snap track hanger brackets adjust to fit 4"-6" tray.

Universal Bracket



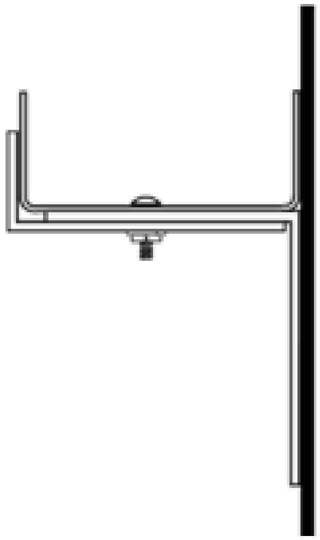
The Snap Track universal bracket is used for horizontal or vertical mounting. It is manufactured from 1 5/8" slotted strut with side slots added for versatility.

Single Strut Cantilever Brackets



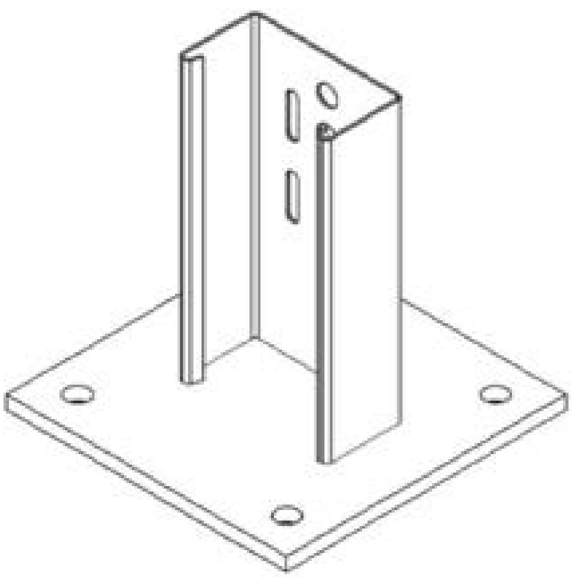
Snap Track cantilever brackets are available in 12", 18, and 24" lengths and are manufactured from either 1-5/8" slotted or solid strut. Horizontal and vertical configurations are available.

Wall Brackets



Snap Track wall brackets are used for horizontal wall mounting. The brackets adjust to 4" and 6" trays.

Post Base Mounts



Snap Track post base attaches vertical runs to the foundation on an 8" X 8" base plate.

Understanding Grounding and Bonding

A channel tray system must provide protection to life and property against faults caused by electrical disturbances, lightening, failures which are part of the system, and failures of equipment that is connected to the system. Article 250 of the *NEC* provides the minimum requirements for grounding and bonding. Article 392 provides guidance and minimum requirements specific to cable trays. **TechLine Mfg. recommends engineers and designers follow the grounding and bonding requirements as outlined by NEC.**

To understand these *Code* requirements adequately, one should always be familiar with defined terms related to the subject matter. Understanding how the defined terms are used within the *Code* will provide users an improved understanding of how the rules apply to installations and the Snap Track system.

Definition of Terms

Bond (Bonded) (Bonding)

Connected to establish electrical continuity and conductivity.

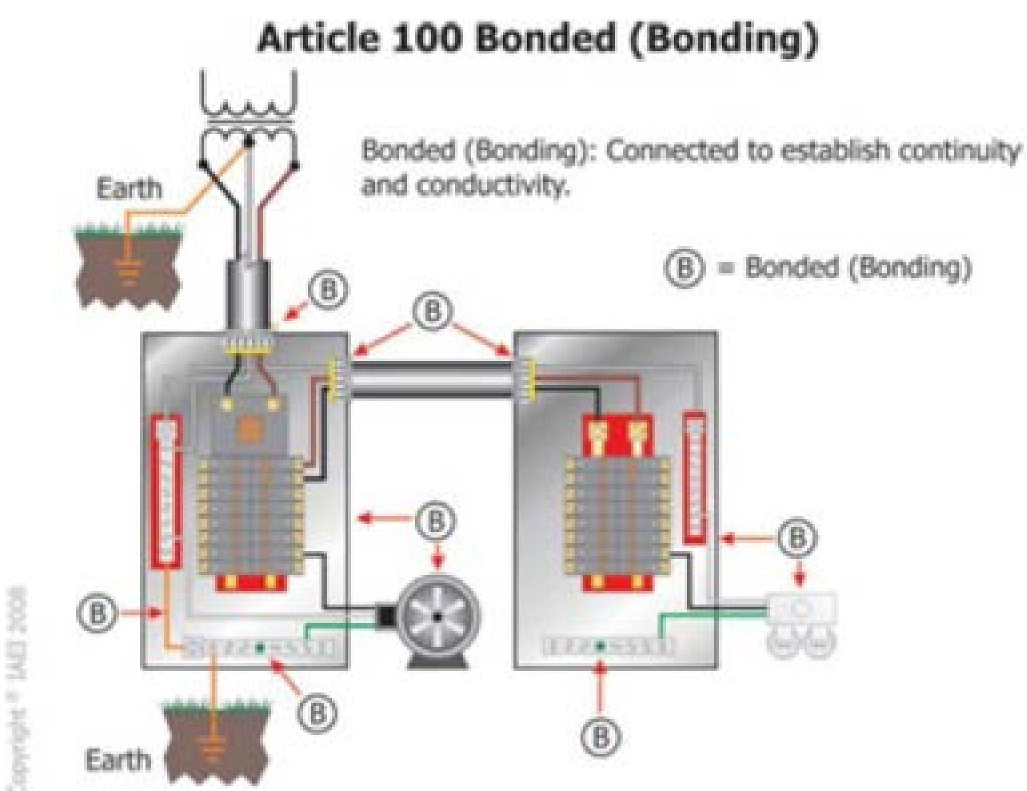
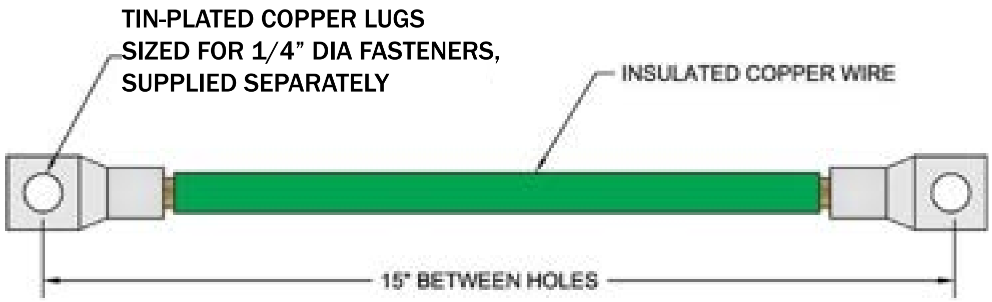


Figure 1. Bonding establishes continuity and conductivity

Bonding Conductor or Jumper

A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected.



Ground (Grounded) (Grounding)

Connected (connecting) to ground or some conductive body that extends the ground connection.

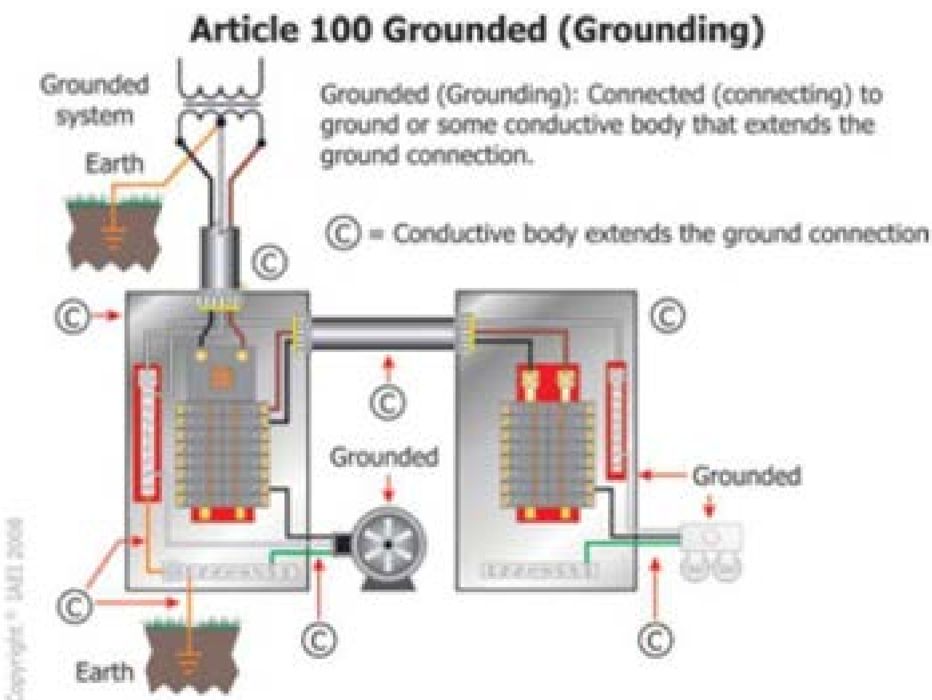


Figure 2. Grounding means "connected to ground or a conductive body that extends the ground connection.

Equipment Ground Conductor (EGC)
The conductive path installed to connect normally non-current carrying metal parts of equipment together and to the system ground conductor or to the grounding electrode conductor, or both.

Informational note: *It is recognized that the equipment ground conductor also performs bonding.*

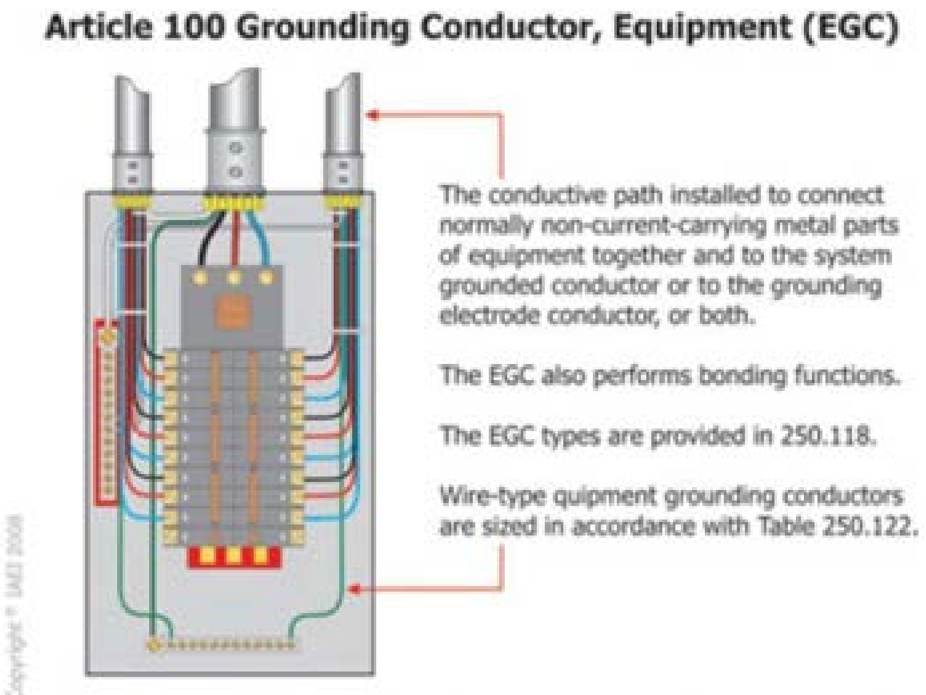


Figure 3. Equipment grounding conductor performs grounding, bonding, and serves as the effective ground-fault current path.

What Equipment Ground Conductors Accomplish

Equipment grounding conductors essentially perform three basic functions. This component of the grounding and bonding scheme in the electrical system is a multitasking conductor.

1) The first task accomplished by the equipment ground conductor is to establish a conductive connection to ground (the earth) for the electrically conductive parts of equipment. This helps minimize the possibility of electric shock for persons that come into contact with equipment or in our case the cable tray system.

2) The second task performed by the equipment ground conductor is bonding. It is clear that within the *NEC* definition for a grounding conductor, equipment (EGC) that bonding is a performance characteristic of this safety circuit.

3) The third task performed by the equipment ground conductor is that it serves as an effective ground-fault current path to facilitate overcurrent device operation in the event of a ground-fault conditon in the system.

Bonding

Bonding requirements for metallic cable trays are addressed by NEC article 392.60 and article 250.

Article 392.60 states that metallic cable trays that **support electrical conductors shall be grounded as required for conductor enclosures in accordance with 250.96 and Part IV of article 250. Cable trays containing nonpower conductors shall be <u>electrically continuous</u> through *approved* connections or the use of a bonding jumper.**

Article 250.96 states Metal raceways, **cable trays**, cable armor, cable sheath, enclosures, frames, fittings, and other metal noncurrent carrying parts **that are to serve as equipment grounding conductors, with or without the use of supplementary equipment grounding conductors, <u>shall be bonded where necessary to ensure electrical continuity</u>** and capacity to conduct safely any fault current likely to be imposed on them. Article 250 Part IV states Metal enclosures and raceways for service conductors and equipment shall be connected to the grounded system conductor if the electrical system is grounded.

In summary, all cable trays should be electrically continuous. In the case of Snap Track, this is accomplished through our UL Classified (*approved)* connection and the use of bonding jumpers. **<u>Bonding jumpers should be installed with thermal expansion splices, adjustable fittings, and any mechanically disconnected section. Bonding jumpers should also be installed when transitions are made between Snap Track and other cable trays, raceways or conduits. The tray should also be bonded back to the power source.</u>**

The criteria or governance for an *approved connection* is found in NEMA BI-50016 section 5.1.2 Electrical Continuity of Connections – A current of 30 A dc shall be passed through the specimen and the resistance measured between two points located 1.6 mm (1/16 in.) from each side of the splice or coupling. The net resistance of the connection shall be not more than 0.00033 ohm as computed from the measured voltage drop and current passing through the specimen, at an ambient temperature of 1535 C (6095 F). The current source shall be applied at least 300 mm (12 in.) on either side of the splice or coupling.

The electrical continuity of the Snap track connection has been tested by Underwriters Laboratory, under file number E249472, and was found to exceed the requirements as defined by NEMA BI-50016 section 5.1.2.

(Resistance = Voltage/30)

RESULTS

STCS 2-2AL and STPACS 2-2AL fittings (sample tag 1039704-001) With Cat. No. STC 2-2AL Cable Tray (Sample Tag 1049130-001) and Cat. No. STSLP 9.22T Push Pin Connectors (sample tag 1039704-001)

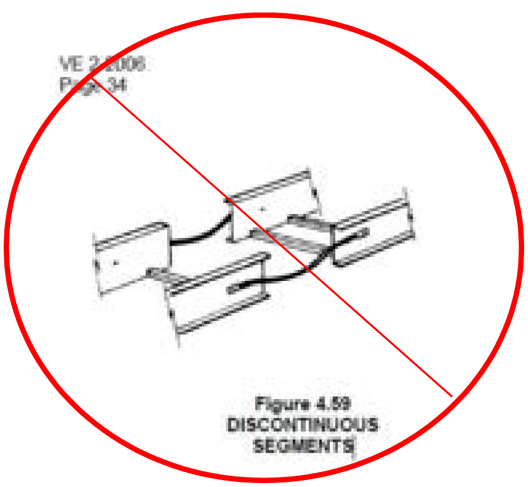
Location	Voltage Drop (V)	Resistance (ohm)
1. ~~STCS 2-2AL to STC 2-2AL~~ to STPACS 2-2AL (top)	0.0025	0.00008
2. STPACS 2-2AL to STC 2-2AL splice plate (opposite top)	0.0028	0.00009
3. STPACS 2-2AL to STC 2-2AL splice plate (bottom)	0.0025	0.00008
4. STCS 2-2AL to STPACS 2-2AL (opposite bottom)	0.0025	0.00008

NOTE: Cat. Nos. changed by Project Handler to represent actual assembly. RAF 2008-09-25

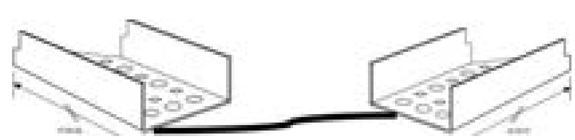
NOTE: The fitting STCS 2-2AL (sample tag 1039704-001) was connected to the cable tray STC 2-2AL (sample tag 1049130-001), which was connected on the other end to the fitting STPACS 2-2AL (sample tag 1039704-001).

Informational Note: *When bonding jumpers are required, electrical continuity can be achieved using a single bonding jumper attached to the existing holes in the base of the Snap Track tray.* ***It is not necessary to drill holes in the side rails and to install two bonding jumpers as described in NEMA 50016 Section 3.8.4 and depicted in figures 395 398.*** *Snap Track is a ventilated channel with integral side walls. Section 3.8.4 is referring to the installation of bonding jumpers for ladder tray.*

Additionally, NEMA 50016 is not a Standard as is NEMA 50015, rather NEMA 50016 is as stated in the forward a practical guide.



Two (2) bonding jumpers are required for ladder tray.



A single bonding jumper will achieve electrical continuity based on the integral side walls.

Note: *Bonding Jumpers must be installed in the following instances:*

1. *Beginning and end of tray run*
2. *Mechanically discontinuous sections*
3. *When using an adjustable fitting*
4. *Thermal expansion joints*

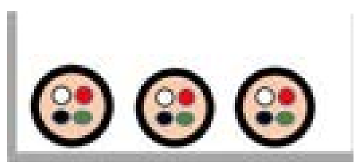
Equipment Grounding

Equipment grounding means the connection to earth of all exposed, non-current carrying metallic parts of the components of the electrical distribution system. The purpose of equipment grounding is to prevent a voltage higher than earth potential on the Snap Track (cable tray) system or equipment. Grounding thus reduces the danger of shock or fire in the event that a live conductor comes into contact with these conductive parts.

The Equipment Ground Conductor (EGC) is the most important conductor in an electrical system as its function is electrical safety.

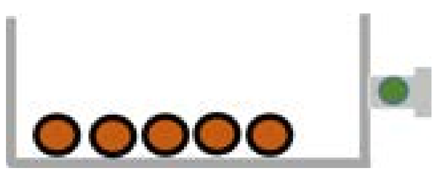
There are three wiring options for providing an EGC in a cable tray wiring system:

1) Each multiconductor cable with its individual EGC conductor. This is the most common approach as UL requires all multiconductor cables to contain an integral EGC. It is also the most convenient and cost effective method.



Tray bonded per NEC 250.96 with UL Classified Snap Track Splice. Individual ground connector in multi-conductor cable used as EGC.

2) A separate EGC conductor in or on the cable tray. This method is commonly selected when single conductor cables are used, typically only in a few industrial applications. When a separate EGC is utilized it must be sized in accordance with NEC table 250.122.



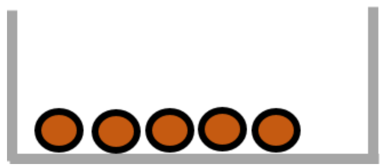
Tray bonded with continuous ground conductor sized for max breaker.

***NEC Table 250.122* Minimum Size Equipment Grounding Conductors for Grounding**

Raceway and Equipment

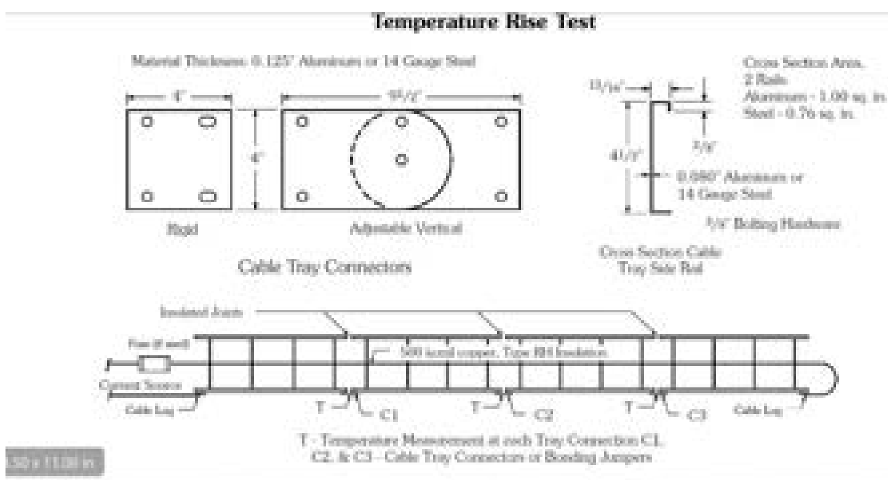
Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit Etc. Not Exceeding (Amperes)	Wire Size AWG or kcmil	
	Copper wire Size	Aluminum or Copper – Clad Aluminum*
15	14 AWG	12 AWG
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250 kcmil
1600	4/0	350
2000	250 kcmil	400
2500	350	600
3000	400	600
4000	500	800
5000	700	1200
6000	800	1200
** See Installation restrictions in 250.120*		

3) The cable tray itself used as the EGC in qualifying facilities. NEC Article 392.6 states the metalic cable trays shall be permitted to be used as equipment ground conductors where continuous maintenance and supervision ensure that qualified persons service the installed cable tray system and the cable complies with the provisions of this section.



Tray bonded per NEC 250.96 with UL Classified Snap Track Splice and utilized as an equipment ground connector per NEC 392.60.

The subject of using cable tray for equipment grounding conductors was thoroughly investigated by the 1973 NEC Technical Subcommittee on Cable Tray. Many calculations were made and a number of tests were performed by Monsanto Company Engineers at the Bussman High Current Laboratory. The test setup to verify the capability of cable tray to be used an EGC is shown below.



The test amperes available were forced through one cable (ladder) tray side rail which had three splice connections in series. No conductive joint compounds were used at the connections and the bolts were wrench tight. Copper jumper cables were used from the current source to the cable tray. The cable tray was NEMA Class 12B.

The test concluded that if the protective devices worked properly, the temperature rise recorded at the splice connection during these tests would not be sufficient to damage the cables in the cable tray.

As a result of these tests, cable trays were allowed to be used as an EGC. The use of cable trays as an EGC is now governed under NEC article 392.60. NEC Article 392.60 permits aluminum and steel cable trays to be used an an EGC providing the following requirements are met:

NEC 392.6 (A)
Where continous maintenance and supervision ensure that qualified persons service the installed cable tray system.

NEC 392.6 (B)

a) The cable tray sections and fittings are identified as an equipment ground con ductor.

b) The minimum crosssectional area of the cable trays conform to the requirements in Table 392.60 (A.)

Table A

Table 392.60(A) Metal Area Requirements for Cable Trays Used as Equipment Grounding Conductor

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[a]			
	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[b]	258	0.40
1000	—	—	387	0.60
1200	—	—	645	1.00
1600	—	—	967.5	1.50
2000	—	—	1290	2.00[b]

[a]Total cross-sectional area of both side rails for ladder or trough cable trays; or the minimum cross-sectional area of metal in channel cable trays or cable trays of one-piece construction.

[b]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.

Under our UL file number E249472 Snap Track has been UL Classified as suitable for use as an EGC with the following crosssectional areas.

Table B

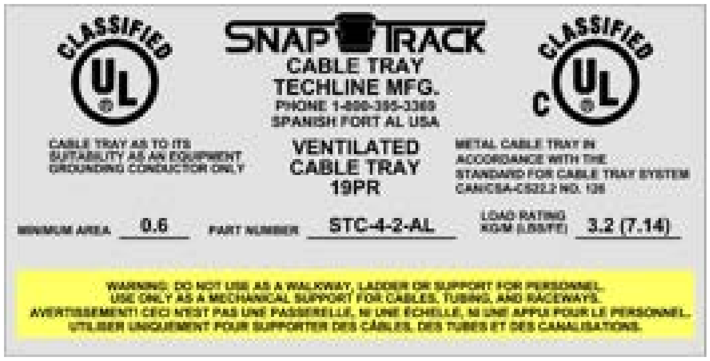
Cat. No.	Height	Width	Thickness	Minimum Cross Sectional Area (Marked) in²
Galvanized Steel				
TLC-2-2 HDG	2.0	2.0	0.075	0.4
TLC-4-2 HDG	2.0	4.0	0.08	0.4
TLC-6-2 HDG	2.0	6.0	0.08	0.4
Aluminum				
TLC-2-2 AL	2.0	2.0	0.097	0.4
TLC-4-2 AL	2.0	4.0	0.097	0.6
TLC-6-2 AL	2.0	6.0	0.097	0.6
STC-2-2 AL	**2.0**	**2.0**	**0.100 min.**	**0.4**
STC-4-2 AL	**2.0**	**4.0**	**0.100 min.**	**0.6**
STC-6-2 AL	**2.0**	**6.0**	**0.100 min.**	**0.6**

Based on the UL Classified crosssectional area Snap Track 2" tray and fittings are suitable for use as an EGC up to 600 Ampere and Snap Track 4"-6" tray and fittings are suitable for use as an EGC up to 1000 Ampere.

Note: *The crosssectional area of our fittings is greater than that of the tray.*

The surface area dictates the amount of current or ampere that can be conducted without undue temperature rise. This is the same reason that NEC Table 250.122 utilizes different size (AWG) cables for use as an EGC for various amperage ratings. It is not the connection, as the connection has been UL Classified as bonded under the NEMA BI-50016 5.1.2 requirement and the test conducted by UL.

3) All cable tray sections and fittings are legibly and durably marked to show the cross- sectional area of metal in the cable trays, or cable trays of one piece construction, and the total crosssectional area of both side rails for ladder and trough cable trays.



4) Cable Tray sections, fittings, and connected raceways are bonded in accordance with 250.96, using bolted mechanical connectors or bonding jumpers sized and installed in accordance with 250.102

The Snap Track connection is UL Classified as bonded, and the bonding capability meets the requirements set forth for bolted connections. When the code was originally written the only available method of bonding fittings and sections was a bolted connection.

System Grounding

A system ground refers to the point in an electrical circuit that is connected to earth. This connection point is typically at the electrical neutral. When properly grounded by means of a low-resistance conductor of sufficient capacity, a system ground provides a low impedance path for fault currents or excessively high voltages that may accidently come on the tray system. Faults or excessively high voltages will be carried off to earth immediately with a minimum danger of fire or shock. In a grounded system, an accidental grounding of one of the current carrying conductors will result in a short circuit and cause a fuse or circuit breaker to open.

Methods of Grounding:

Effective grounding must be permanent / continuous and have ample capacity to safely conduct any current likely to be imposed on the system. It should also have impedance sufficiently low to limit the potential above ground and facilitate the operation of over current devices in the circuit. A continuous, underground metallic water supply system is acknowledged to be the best electrical ground. Other suitable methods include continuous metallic steam and gas piping systems, the grounded metal frame of a building or structure, or artificial electrode such as driven steel pipe, galvanized or otherwise protected from corrosion, or a buried metallic plate.

Informational note: *Wherever multiple grounds are used, it is important that they be tied together in order to avoid any difference in potential between the various parts of the tray system.*

NEC article 392.60 requires that metallic cables trays that support electrical conductors shall be grounded in accordance with 250.96.

In general, noncurrent carrying parts of equipment that are likely to become energized are required to be bonded to an equipment ground. In addition to article 250.96 this requirement is also clearly stated in articles 250.110, 250.112 and 250.134.

Where cable tray systems contain only nonpower circuit(s) article 392.6 requires the cable tray system only to be electrically continuous. However, even in nonpower applications, cable trays are generally still grounded for lighting protection, noise, electromagnetic interference, and static discharge.

TechLine Mfg. recommends, as an accepted best practice, all Snap Track cable tray installations should be bonded to building steel or the facility grounding system every 60'. By bonding every 60', the tray will maintain a low potential to ground, which reduces EMI and provides a continuous path for stray currents.

Supports securely fastened to building steel usually provide a solid bond. ***When spans exceed 60' and are not inherently bonded to building steel and earth through metallic supports the tray should be bonded to an additional EGC connecting to earth or the facility ground network.***

WARNING: IT IS THE RESPONSIBILTY OF THE DESIGNER AND INSTALLER TO ENSURE THAT THE SNAP TRACK SYSTEM IS PROPERLY BONDED TO THE POWER SOURCE AND THE GROUND NETWORK INCLUDING A PROPER SYSTEM GROUND.

Complete rules for grounding are contained in Article 250 of the National Electrical Code.

Accessories

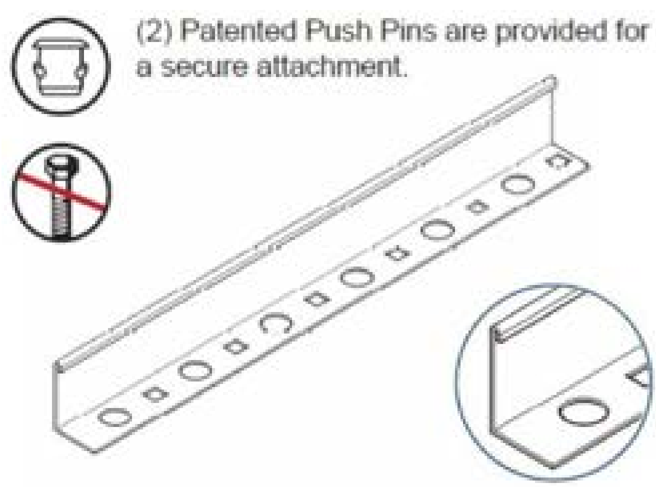
The Snap Track system contains accessories both common and unique. This section is intended to provide designers and engineers with an understanding of the proper use of the more common accessories and the many unique solutions available. Designers and engineers are encouraged to refer to the current Snap Track catalog for a complete listing.

A.) Common Accessories

1) Divider Strips – Divider strips are used to separate power and data cables within the Snap Track tray. Snap Track divider strips assemble to the tray with the patented Snap Track Push Pin. Dividers are manufactured from 18 Ga. Aluminum, and are easily field modified with tin snips for changes in radius and level.

Design Guideline: Whenever possible, power cables and data cables should be run in separate trays to prevent electromagnetic interference. When this is not possible, dividers should be installed to provide an EMI barrier.

EMI (electromagnetic interference) is the disruption of operation of an electronic device, when in the vicinity of an electromagnetic field in the radio frequency (RF) spectrum, that is caused by another electronic device.



2. Dropout Fittings - Transitions in and out of traditional ladder tray have been commonly available for many years. However, exiting and entering channel trays have traditionally required field fabrication and resulted in unprotected sections of cable. For this reason, TechLine Mfg. has and will continue to develop unique solutions.

Waterfall Exit Fittings
Assembles onto any size Snap Track tray spilling over the side and transitioning into a vertical tray. Waterfalls mount directly to existing tray without alterations or tools.

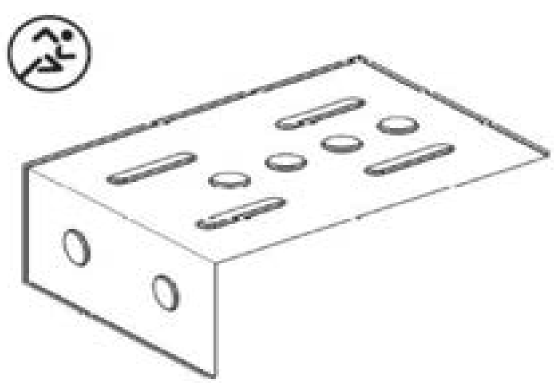
Downspout Exit Fittings
Create a 90° 2” x 2” spill out transition from the center of a horizontal or vertical run. The fittings maintain a 3” bend radius controlled throughout the transition to the downspout.

Drop Tee Fittings
Create a 90° 2” spill out transition on a horizontal run. Drop tees are available in multiple radii and typically used when a bend radius over 3” is required.

Take-Off Fittings

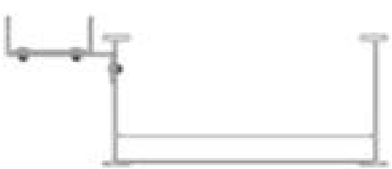
Are designed to transition cables from the tray sections to point of use. Snap Track Take - off fittings can be ordered in an array of sizes and configurations.

3. Channel Tray - to - Ladder Tray Brackets – Snap Track was designed to transition cables from ladder tray to point of use, typically as an alternative to conduit. As such TechLine Mfg. offers a variety of Snap Track brackets to transition from ladder tray.

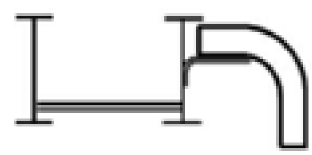


Ladder Tray Bracket

Attaches to the side rail of the ladder tray and allows for the connection of any Snap Track fitting or tray.



Ladder Tray Waterfall



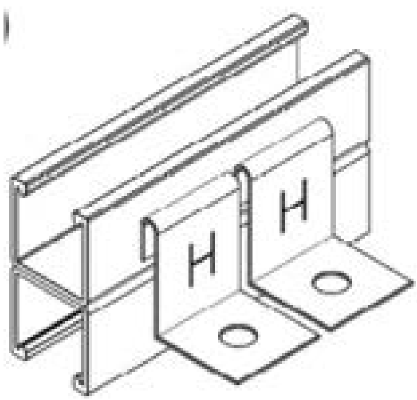
Installation Guide: Bolt Transition Bracket a minimum of 2.5” below the bottom lip of the ladder tray side rail top flange. Either horizontal or perpendicular Snap Track cable tray runs can then be attached with two push pins.

Installation Guide: Vertical Drops to create a ladder transition Waterfall, bolt the Ladder Tray Transition Bracket a minimum of 2.5” below the bottom lip of the ladder tray side rail top flange. Then attach the appropriate width Snap Track 3”, 6”, or 12” Vertical Outside Radius Fitting.

4 **Conduit - to - Channel Tray Adapters** - Although Snap Track was designed as an alternative to conduit, requirements for conduit transitions do exist. Designers and engineers may also consider it "best practice" to utilize conduit when transitioning some types of cables from Snap Track to equipment or point of use. For these reasons TechLine Mfg. offers several methods for connecting conduit to Snap Track.

Conduit Outlet Splice

Allows for hardwire solutions by providing a direct conduit connection to any size *Snap Track* tray. Alternating ½" and 1" conduit knockouts that are centered on both the side rails to provide up to four conduit entries.



Conduit Bracket

Snap Track Conduit brackets allow for an easy transition from cable tray to conduit. The two hold down clamps slide over the side rail of the tray and are secured with two patented push pins. The conduit can enter / exit from the top or bottom of the tray. Conduit is secured utilizing traditional strut clamps.

End Plates

Snap Track end plates are used for dead-end closure and indicates the termination of a cable tray run.

Conduit knock outs are provided for the attachment of conduit to the cable tray. Grommets are also available.

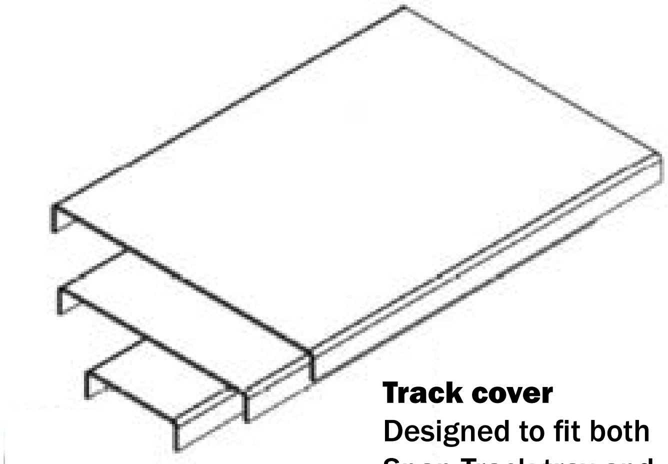
Informational Note: *In order to make an electrical connection without a UL listed connector an equipment ground conductor must first be run from the conduit to the cable tray when installing ANY Snap Track conduit adapter.*

5) Covers and Clamps – Covers are typically added to the Snap Track system in areas where additional cable protection is required. Many engineers and facilities also utilize covers at grade level (typically sections from grade to sections 6'-7' above grade).

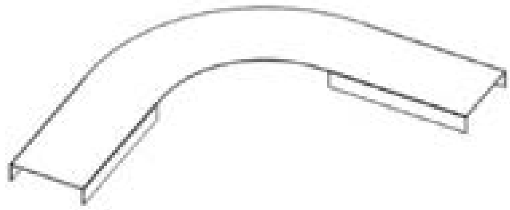
Although covers provide for maximum cable protection, the addition of covers inhibits cable access. Realizing that tray rated cables have mechanical and UV protection built into their construction many designers choose to limit the use of covers. Therefore, the use of covers is common only in areas subject to falling debris, excessive air born particles, high access areas, and or other areas where the cable(s) maybe subject to environmental or mechanical damage.

Informational Note: *The Snap Track system utilizes a solid unventilated cover. Designers and engineers should note NEC section 392.80 (B) Ampacity of Conductors, which states – Where cable trays are continuously covered for more than 1.8 m (6 ft.) with solid unventilated covers, not over 95 percent of the allowable ampacity of Table 310.15 (B) (16) and Table 310.15(B) (18) shall be permitted for multiconductor cables.*

Recommended for maximum **Cable Protection**



Track cover
Designed to fit both Snap Track tray and splices.



Fitting cover
Covers are available for all standard Snap Track fittings. Fitting covers are secured with Ready Use Band-It Straps or Snap Track Cover Clamps.

<u>In all cases it is necessary to strap or clamp ALL Snap Track covers.</u> The type and number of straps or clamps is dependent of the design wind load.

Nominal Wind Loads =/< 50 MPH

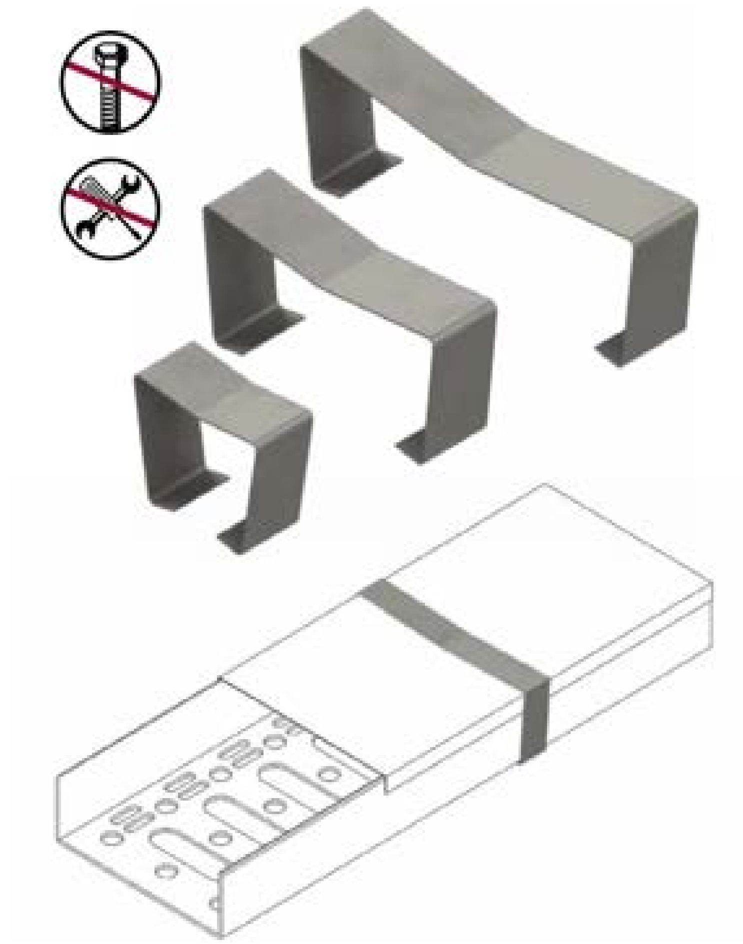
For nominal wind conditions TechLine Mfg. recommends the use of Snap Track Re-Usable Band-It Straps as outlined.

Quantity of Band-It Straps

Straight Sections 3.0 m (10 ft.) 3 pieces	3 pieces
Horizontal / Vertical Bends	3 pieces
Crosses	4 pieces
Crosses	5 pieces

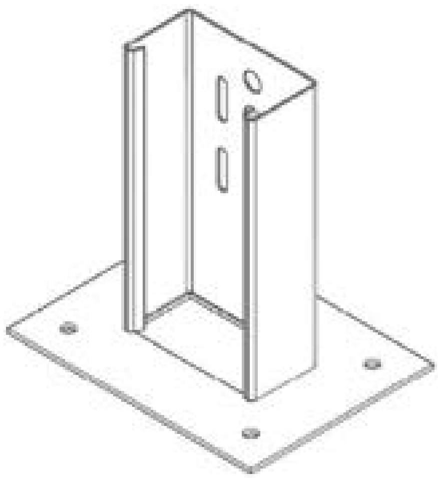
Snap Track Cover Clamps

Snap Track Cover Clamps can be used to assemble Snap Track tray and cover without tools.



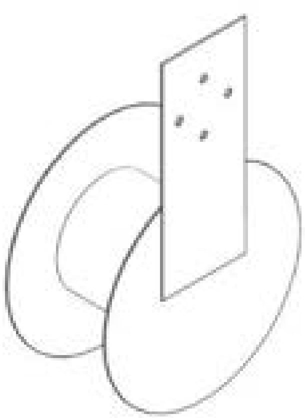
B) Unique Accessories

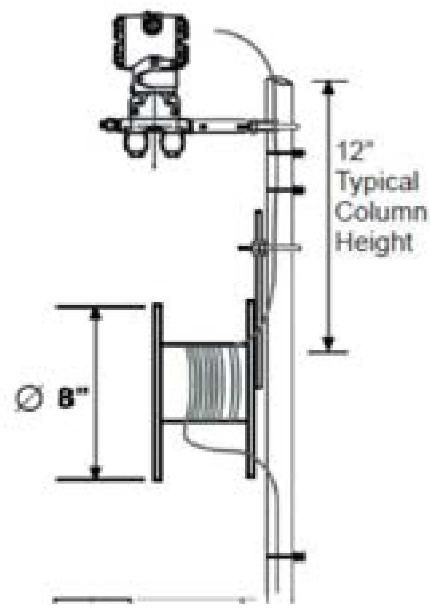
1) Hub Fitting - Snap Track hub fittings are designed to transition Snap Track to enclosures (i.e. junction boxes, wiring panels, and troughs).



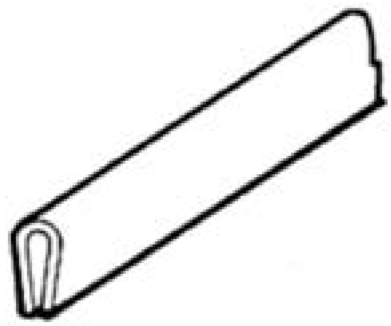
Snap Track Bulkhead Connector
Connects Snap Track to a wiring panel or equipment. An opening that is the size of the channel is in the baseplate of the connector. This allows for transitioning into Snap Track from an enclosed location.

2) Wire Spools - Snap Track wire spools were designed to eliminate "pig tails," which commonly occur at the instrument connection, in connectivity solutions utilizing cord sets.





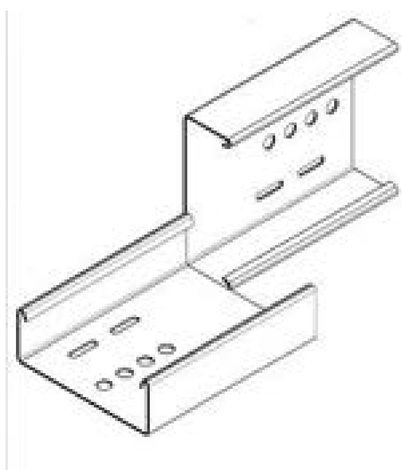
3) Guarding - In accordance with NEC section 392.100 (B), TechLine Mfg. recommends that the ends of **ALL** mechanically discontinuous sections of channel by protected with guarding. This requirement by NEC not only will protect the cable from damage but also to protect personnel from injury.



Guarding

Snap Track guarding is designed to provide protection from potentially sharp edges that may result from cut sections of channel.

4) Plane Adapters - The Snap Track system is plane dependent. Therefore, TechLine Mfg. has incorporated into the Snap Track system a complete line of plane adapters.



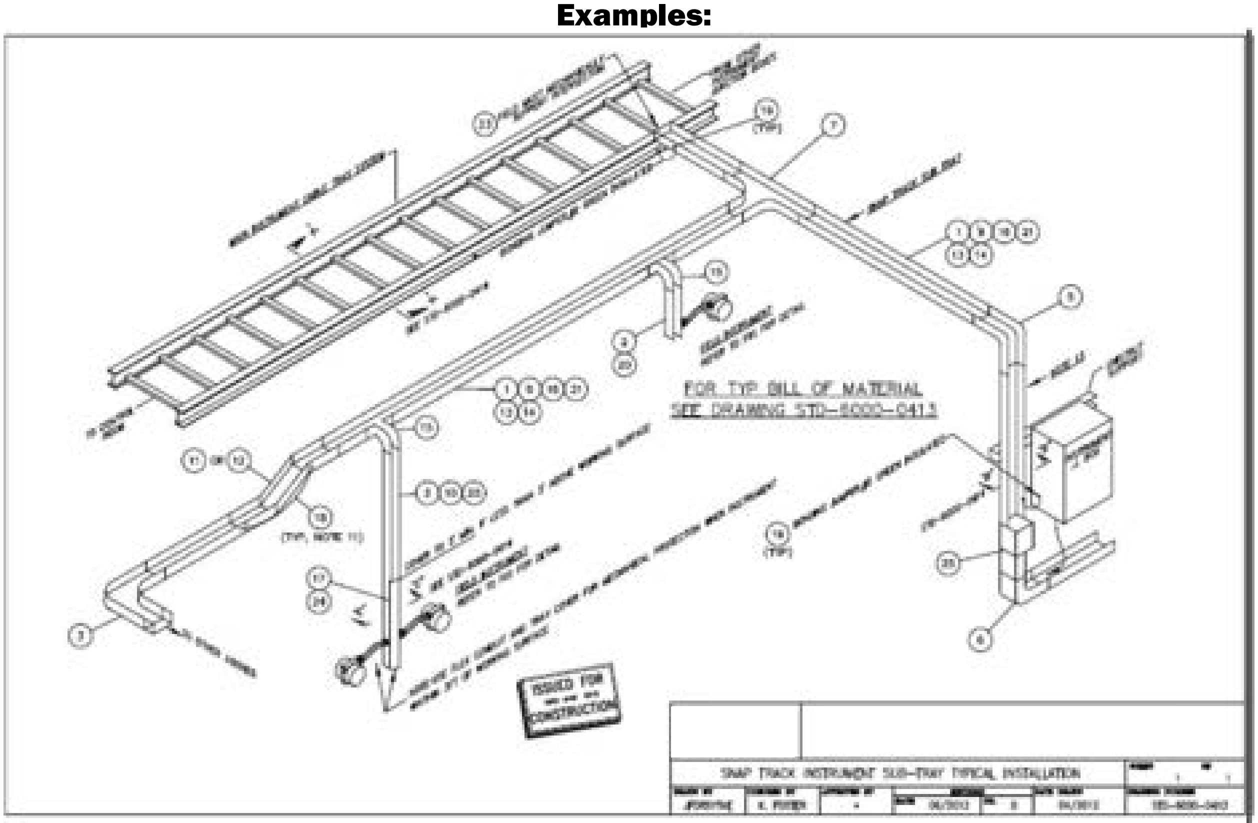
Plane Adapters

Snap Track plane adapters can change the plane of the channel run 90 degrees in either direction or 180 degrees.

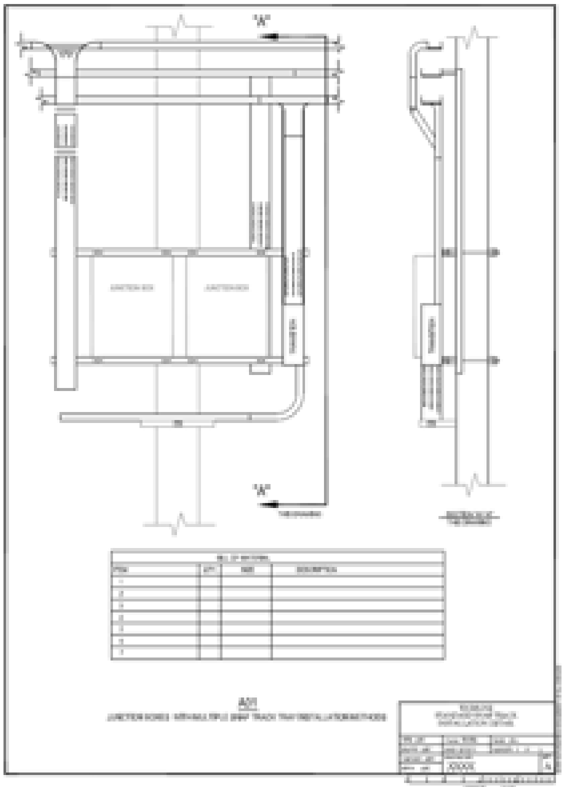
Engineering Design Criteria

<u>The Snap track system is typically field routed and as such the final layout determination is best left to the installer.</u> However, in some markets, the routing and installation of ventilated bottom channel tray, used as an alternative to conduit, is a new practice. In these cases, or where Snap Track, or similar technologies have not been previously deployed, TechLine Mfg. recommends that guidance be given by the engineering firm, system designer, architect, or qualified owner. Generally, guidance for the installer should include an overall system concept detailing the desired approach, typical point of use installation details, a wiring fill table, and specified maximum span distances.

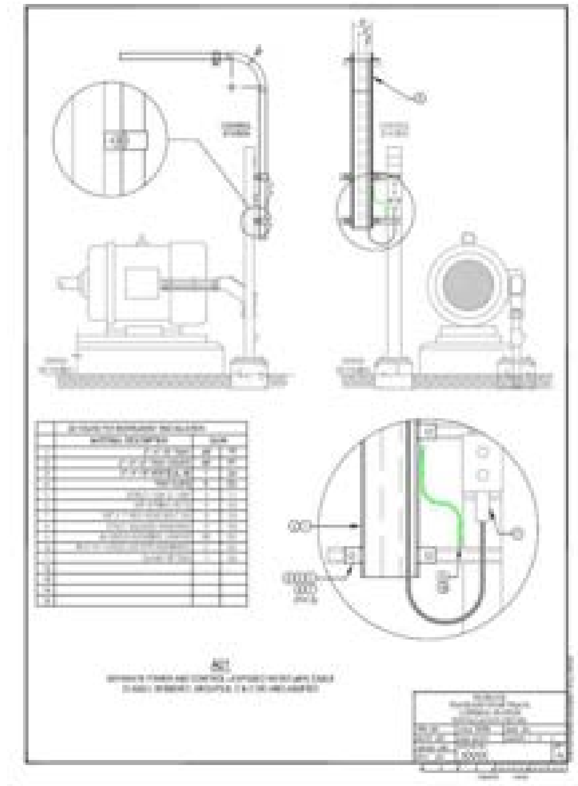
Examples:



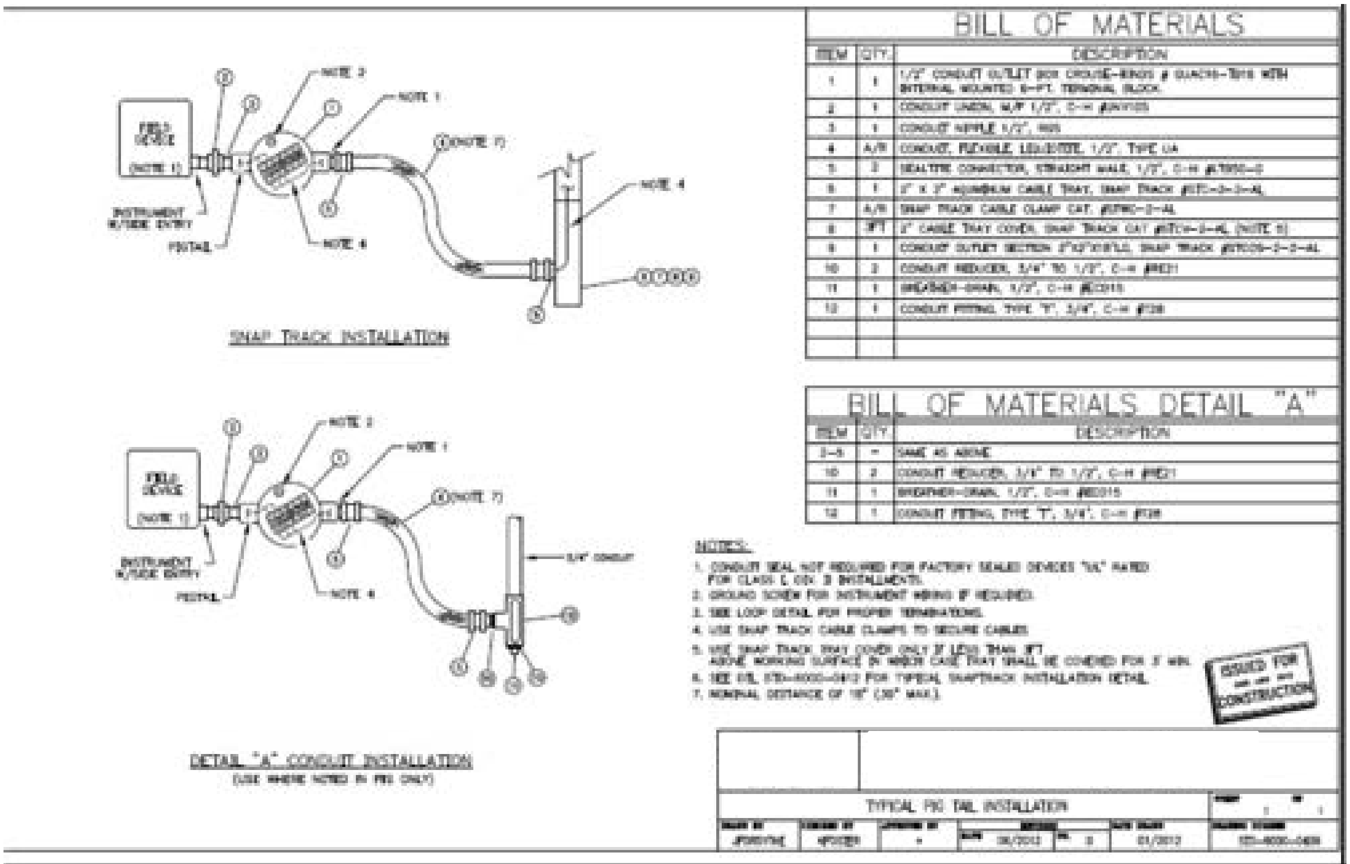
Example System Concept



Example
Point of Use – Junction Box



Example
Point of Use – Motor Station



Example

Point of Use - Field Device

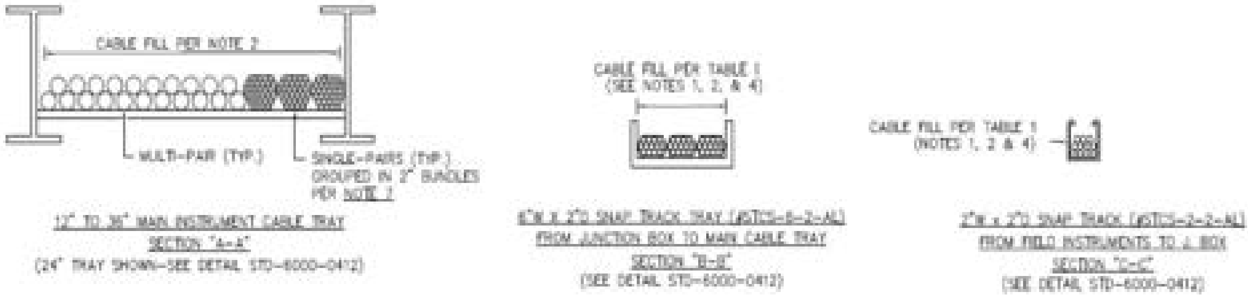


TABLE NO.1 SNAP TRACK TRAY FILL CHART

FIELD TO DETERMINE FILL FOR DIFFERENT COMBINATIONS OF CABLE SIZES

CABLE TYPE	CABLE DESCRIPTION	O.D.	AREA	2"X2" (MAX FILL AREA 2SQ-IN)	6"X2" (MAX FILL AREA 6SQ-IN)
101	1PR#16, W/OA SHLD.	.32"	.09"	22	66
102	4PR#16, W/OA SHLD.	.63"	.32"	6	18
103	8PR#16, W/IND & OA SHLD.	0.811	0.52	3	11
104	12PR#16, W/IND & OA SHLD.	1.017	0.82	2	7
105	24PR#16, W/IND & OA SHLD.	1.39	1.52	1	4
106	36PR#16, W/IND & OA SHLD.	1.593	2.00	1	3
108	1PR#14, W/OA SHLD.	0.35	0.10	20	60
109	1TR#16, W/OA SHLD.	0.343	0.10	20	60
110	4TR#16, W/IND & OA SHLD.	0.672	0.36	5	16
111	8TR#16, W/IND & OA SHLD.	0.902	0.64	3	9
112	12TR#16, W/IND & OA SHLD.	1.084	0.93	2	6
114	24TR#16, W/IND & OA SHLD.	1.477	1.72	1	3
115	36TR#16, W/IND & OA SHLD.	1.691	2.25	1	2
116	12PR#20,TYPE JX W/IND & OA SHLD.	0.708	0.40	5	15
117	1PR#20,TYPE JX W/OA SHLD.	0.236	0.50	4	12
118	24PR#20 TYPE JX, W/IND & OA SHLD.	0.972	0.75	2	8
121	50PR#16, W/OA SHLD.	1.538	1.86	2	3
122	1PR#20 TYPE KX, W/OA SHLD.	0.236	0.05	40	120
123	24PR#20 TYPE KX, W/IND & OA SHLD	0.972	0.75	2	8
124	36PR#20 TYPE KX, W/IND & OA SHLD	1.105	0.96	2	6
125	8PR#20 TYPE KX, W/IND & OA SHLD.	0.575	0.26	7	23
126	8PR#20 TYPE JX, W/IND & OA SHLD.	0.575	0.26	7	23

Example
Wiring Fill Table

Either by qualified field personnel or through detailed design layout, by engineers, designers, architects, or qualified owners, the final design layout should include the following criteria and considerations:

1. **Compatibility of 6063 –T6 Marine GradeAluminum**
2. **Channel Size and Capacity**
3. **Utilization of Fittings and Accessories**
4. **Thermal Expansion**
5. **Total Load Requirements - Including OutdoorFactors**
6. **Support System Requirements – Types and SpanDistances**
7. **Proper Bonding**
8. **Proper Grounding**

For more information on the Snap Track system, modeling files, catalog pages, cut-sheets, etc., please visit our website at www.techlinemfg.com or contact our sales team at sales@techlinemfg.com.