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**TABLE I
TEMPERATURE RISE TESTS, CABLE TRAY CONNECTORS,
CLASS II ALUMINUM LADDER CABLE TRAY**

Test Current Amps And Fuse Size*	Test Time Cycles	I ² T mult. by 10 ⁶	Connector Data								
			C1			C2			C3		
			Type Of Connector	No. & Type Bolts	Temp. Rise °C	Type Of Connector	No. & Type Bolts	Temp. Rise °C	Type Of Connector	No. & Type Bolts	Temp. Rise °C
7,900 1,200A Fuse	66	69	Adj. Vert. 1 Bolt**	4 Steel	6	3/0 CU Bond	AL-CU Lugs	18	Rigid Clean	2 Steel	8
7,900 1,200A Fuse	82	85	Rigid Corroded	4 Steel	10	3/0 CU Bond	AL-CU Lugs	22	Rigid Clean	2 Steel	9
12,000	120	288	Rigid Corroded	2 Nylon	50	3/0 CU Bond	AL-CU Lugs	104	Rigid Clean	2 Steel	32
12,000	124	297	Rigid Corroded	4 Steel	40	Rigid Corroded	4 Lugs	46	Rigid Clean	4 Steel	21
34,600	14	280	Rigid Corroded	2 Nylon	34	3/0 CU Bond	AL-CU Lugs	75	Rigid Clean	2 Steel	29
34,400	14	276	Rigid Corroded	4 Nylon	28	Rigid Corroded	4 Steel	35	Rigid Clean	4 Steel	20

**TABLE II
TEMPERATURE RISE TESTS, CABLE TRAY CONNECTORS,
CLASS II STEEL LADDER CABLE TRAY**

Test Current Amps And Fuse Size*	Test Time Cycles	I ² T mult. by 10 ⁶	Connector Data								
			C1			C2			C3		
			Type Of Connector	No. & Type Bolts	Temp. Rise °C	Type Of Connector	No. & Type Bolts	Temp. Rise °C	Type Of Connector	No. & Type Bolts	Temp. Rise °C
1,980 200A, FU	52	3.4	Adj. Vert. 1 Bolt**	4	2	No. 6 CU Bond	AL-CU Lugs	10	Rigid	2	3
1,970 400A, FU	394	25.5	Adj. Vert. 1 Bolt**	4	9	No. 6 CU Bond	AL-CU Lugs	***	Rigid	2	15
1,960 400A, FU	8100	51.8	Adj. Vert. 1 Bolt**	4	18	Rigid	4	23	Rigid	2	32
12,000	120	288	Adj. Vert. 2 Bolts**	4	94	Adj. Vert. 2 Bolts**	4	89	Rigid	4	81
12,000	123	295	Rigid	4	70	Rigid	4	87	Rigid	4	85
34,000	13	250	Rigid	4	71	Rigid	4	57	Rigid	4	69

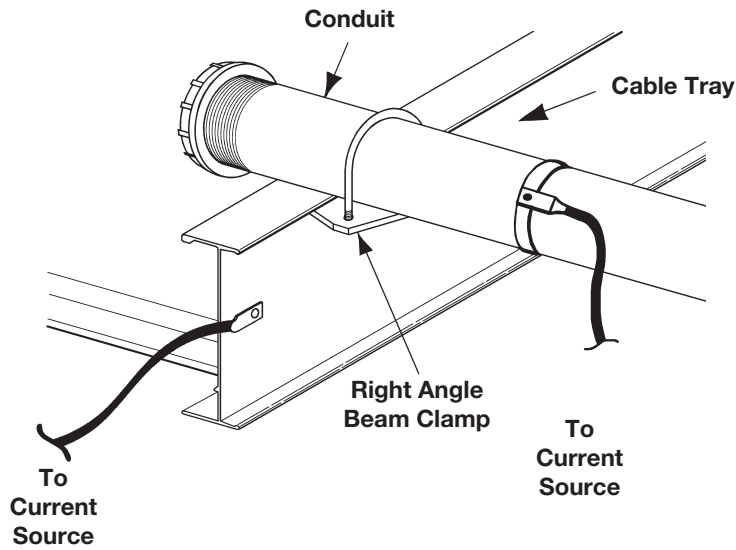
* Test current was interrupted in a predetermined time when a fuse was not used.

** 1 or 2 Bolts - Number of bolts installed on the adjustable vertical connector hinge.

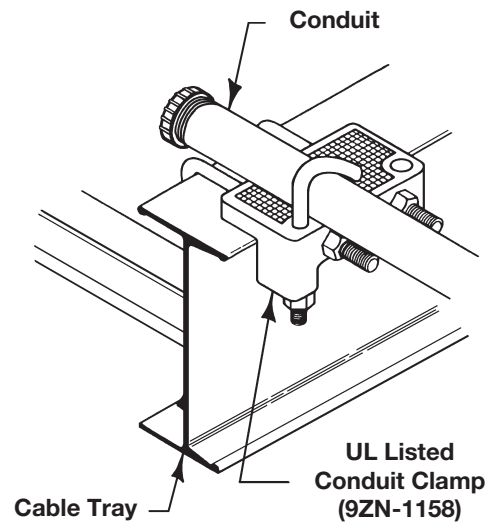
*** The No. 6 bonding jumper melted and opened the circuit when protected by 400A fuse.

(See Page 406 - Figure 1 for Temperature Rise Test illustration)

Appendix Sheet 1



Test Set-Up



Conduit Clamp Detail

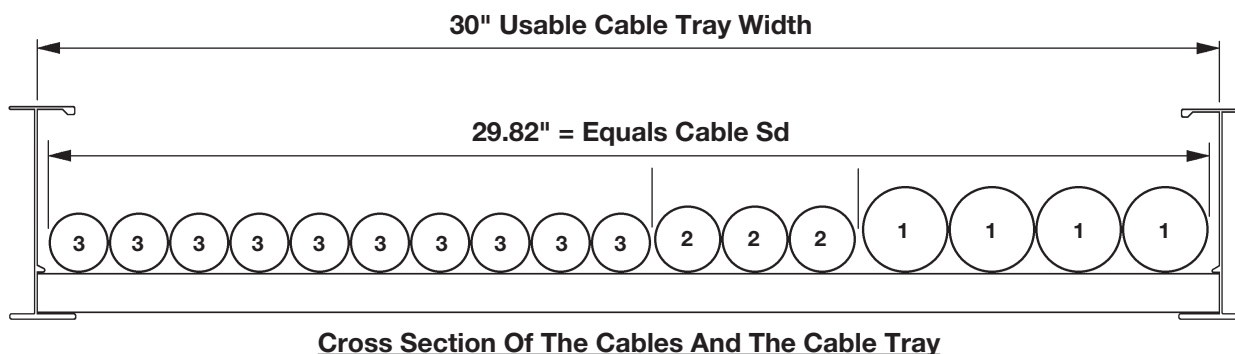
CIRCUIT ARRANGEMENT FOR RIGID CONDUIT TEMPERATURE RISE TESTS

**TABLE III
TEMPERATURE RISE TESTS, CONDUIT CLAMPS
FOR BONDING RIGID CONDUIT TO CABLE TRAY**

Test Current Amperes	Test Time Cycles	I ² T mult. 10 ⁶	Rigid Conduit		Cable Tray		Temp. Rise °C	Condition After Test
			Size	Material	Class	Material		
36,000	16	344.7	4"	Aluminum	II	Aluminum	19	No arcing or damage
20,900	60.5	441.2	4"	Aluminum	II	Aluminum	70	No arcing or damage
12,100	178	433.3	4"	Aluminum	II	Aluminum	74	No arcing or damage
21,000	20	146.8	4"	Steel	II	Steel	(?)	Zinc melted at point where conduit contacted with tray
3,260	900	159.5	4"	Steel	II	Steel	63	No arcing or damage
21,000	30	220	2"	Aluminum	II	Aluminum	21	No arcing or damage
12,100	120.5	294.2	2"	Aluminum	II	Aluminum	59	No arcing or damage
8,000	245	261.1	2"	Aluminum	II	Aluminum	44	No arcing or damage
21,000	14	103.8	2"	Steel	II	Steel	62	Zinc melted at point where conduit contacted with tray
12,000	60.5	145.4	2"	Steel	II	Steel	22	Slight arc between clamp and tray
3,240	600	104.9	2"	Steel	II	Steel	49	No arcing or damage
21,000	20	146.8	1"	Aluminum	II	Aluminum	20	No arcing or damage
12,200	60.5	150.3	1"	Aluminum	II	Aluminum	24	No arcing or damage
12,100	14.5	35.3	1"	Steel	II	Steel	6	No arcing or damage
8,000	63.5	67.84	1"	Steel	II	Steel	59	No arcing or damage
1,980 200A FU	44.5	2.9	1"	Steel	II	Steel	1	No arcing or damage

Example - NEC® Section 392.9(A)(1)

Width selection for cable tray containing 600 volt multiconductor cables, sizes #4/0 AWG and larger only. Cable installation is limited to a single layer. The sum of the cable diameters (Sd) must be equal to or less than the usable cable tray width.



Cable tray width is obtained as follows:

Item Number	List Cable Sizes	(D) List Cable Outside Diameter	(N) List Number of Cables	Multiply (D) x (N) Subtotal of the Sum of the Cables Diameters (Sd)
1.	3/C - #500 kcmil	2.26 inches	4	9.04 inches
2.	3/C - #250 kcmil	1.76 inches	3	5.28 inches
3.	3/C - #4/0 AWG	1.55 inches	10	15.50 inches

The sum of the diameters (Sd) of all cables (Add Sds for items 1, 2, & 3.)

$$9.04 \text{ inches} + 5.28 \text{ inches} + 15.50 \text{ inches} = 29.82 \text{ inches (Sd)}$$

A cable tray with a usable width of 30 inches is required. For a 10% increase in cost a 36 inch wide cable tray could be purchased which would provide for some future cable additions.

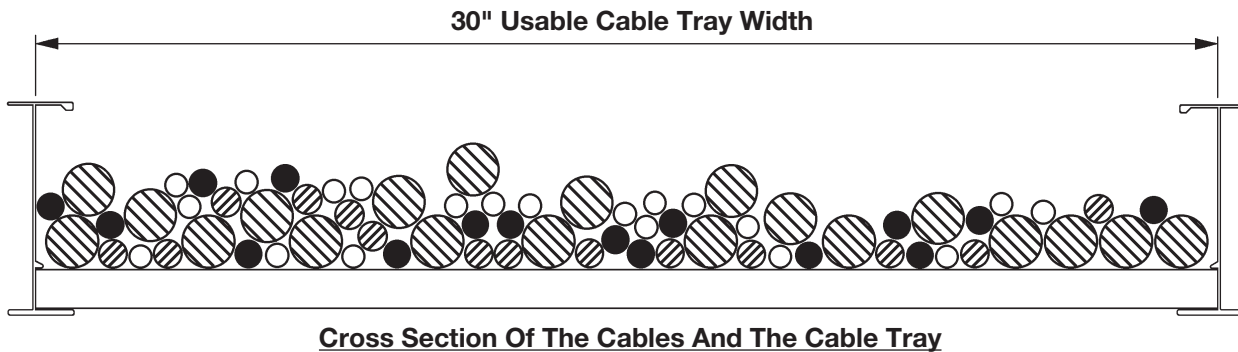
Notes:

- The cable sizes used in this example are a random selection.
- Cables - copper conductors with cross linked polyethylene insulation and a PVC jacket. (These cables could be ordered with or without an equipment grounding conductor.)
- Total cable weight per foot for this installation.
61.4 lbs./ft. (without equipment grounding conductors)
69.9 lbs./ft. (with equipment grounding conductors)
This load can be supported by a load symbol "B" cable tray - 75 lbs./ft.

Cable Tray Manual

Example - NEC® Section 392.9(A)(2)

Width selection for cable tray containing 600 volt multiconductor cables, sizes #3/0 AWG and smaller. Cable tray allowable fill areas are listed in Column 1 of Table 392.9.



Cable tray width is obtained as follows:

Item Number	List Cable Sizes	(A) List Cable Cross Sectional Areas	(N) List Number of Cables	Multiply (A) x (N) Total of the Cross Sectional Area for Each Item
1.	3/C #12 AWG	0.17 sq. in.	20	3.40 sq. in.
2.	4/C #12 AWG	0.19 sq. in.	16	3.04 sq. in.
3.	3/C #6 AWG	0.43 sq. in.	14	6.02 sq. in.
4.	3/C #2 AWG	0.80 sq. in.	20	16.00 sq. in.

Method 1.

The sum of the total areas for items 1, 2, 3, & 4:

$$3.40 \text{ sq. in.} + 3.04 \text{ sq. in.} + 6.02 \text{ sq. in.} + 16.00 \text{ sq. in.} = 28.46 \text{ sq. inches}$$

From Table 392.9 Column 1 a 30 inch wide tray with an allowable fill area of 35 sq. in. must be used. The 30 inch cable tray has the capacity for additional future cables (6.54 sq. in. additional allowable fill area can be used.)

Method 2.

The sum of the total areas for items 1, 2, 3, & 4 multiplied by

$$\left(\frac{6 \text{ in.}}{7 \text{ sq. in.}} \right) = \text{cable tray width required}$$

$$3.40 \text{ sq. in.} + 3.04 \text{ sq. in.} + 6.02 \text{ sq. in.} + 16.00 \text{ sq. in.} = 28.46 \text{ sq. in.}$$

$$\left(\frac{28.46 \text{ sq. in.} \times 6 \text{ in.}}{7 \text{ sq. in.}} \right) = 24.39 \text{ inch cable tray width required}$$

Use a 30 inch wide cable tray.

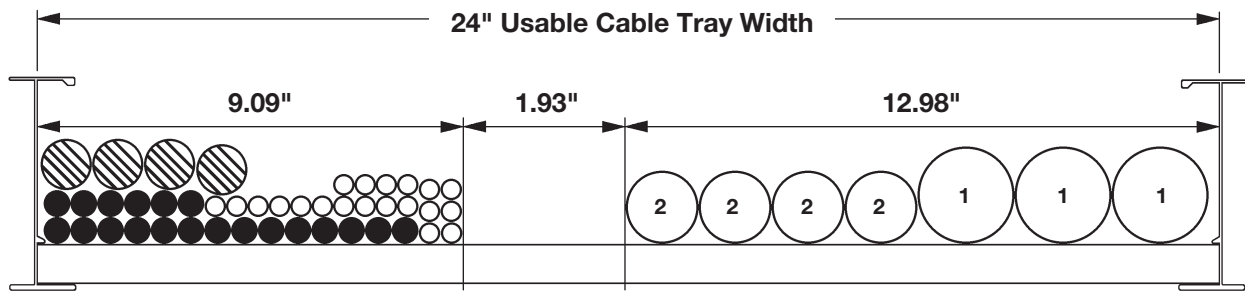
Notes:

- The cable sizes used in this example are a random selection.
- Cables - copper conductors with cross linked polyethylene insulation and a PVC jacket. (These cables could be ordered with or without an equipment grounding conductor.)
- Total cable weight per foot for this installation.
31.9 lbs./ft. (Cables in this example do not contain equipment grounding conductors.)
This load can be supported by a load symbol "A" cable tray - 50 lbs./ft.

Appendix Sheet 4

Example - NEC® Section 392.9(A)(3)

Width selection for cable tray containing 600 volt multiconductor cables, sizes #4/0 AWG and larger (single layer required) and #3/0 AWG and smaller. These two groups of cables must have dedicated areas in the cable tray.



Cross Section Of The Cables And The Cable Tray

Cable tray width is obtained as follows:

A - Width required for #4/0 AWG and larger multiconductor cables -

Item Number	List Cable Sizes	(D) List Cable Outside Diameter	(N) List Number of Cables	Multiply (D) x (N) Subtotal of the Sum of the Cables Diameters (Sd)
1.	3/C - #500 kcmil	2.26 inches	3	6.78 inches
2.	3/C - #4/0 AWG	1.55 inches	4	6.20 inches
Total cable tray width required for items 1 & 2 = 6.78 inches + 6.20 inches = 12.98 inches				

B - Width required for #3/0 AWG and smaller multiconductor cables -

Item Number	List Cable Sizes	(A) List Cable Cross Sectional Area	(N) List Number of Cables	Multiply (A) x (N) Total of the Cross Sectional Area For Each Item
3.	3/C #12 AWG	0.17 sq. in.	20	3.40 sq. in.
4.	3/C #10 AWG	0.20 sq. in.	20	4.00 sq. in.
5.	3/C #2 AWG	0.80 sq. in.	4	3.20 sq. in.

Total cable tray width required for items 3, 4, & 5

$$(3.40 \text{ sq. in.} + 4.00 \text{ sq. in.} + 3.20 \text{ sq. in.}) \left(\frac{6 \text{ in.}}{7 \text{ sq. in.}} \right)^1 = (10.6 \text{ sq. in.}) \left(\frac{6 \text{ in.}}{7 \text{ sq. in.}} \right)^1 = 9.09 \text{ inches}$$

Actual cable tray width is A - Width (12.98 in.) + B - Width (9.09 in.) = 22.07 inches

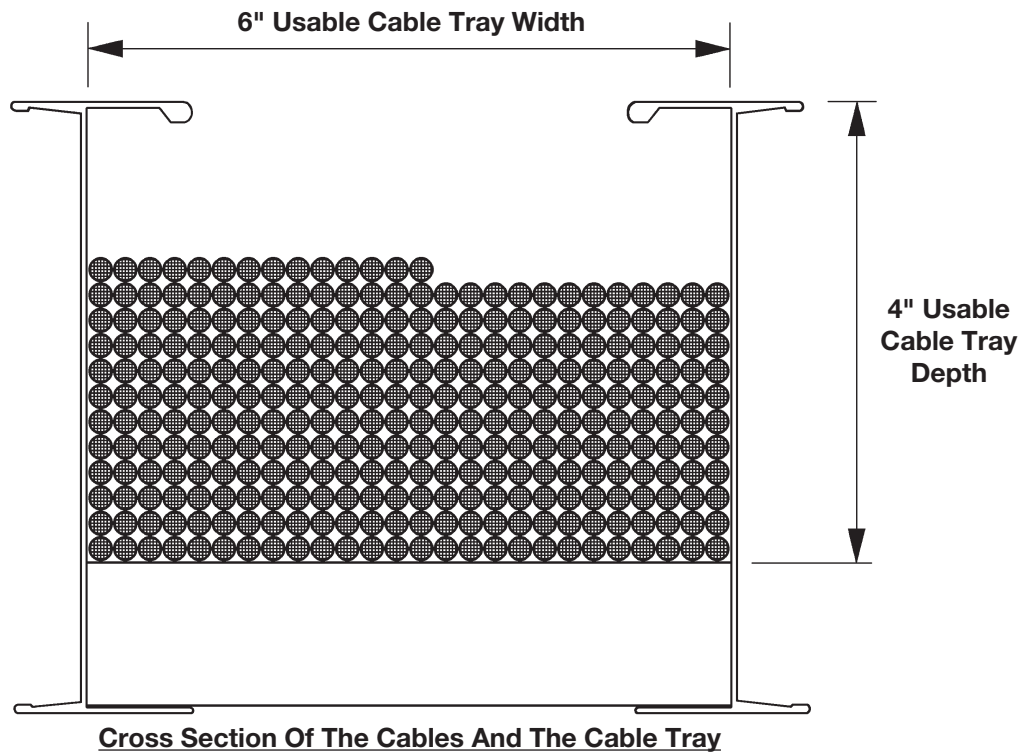
A 24 inch wide cable tray is required. The 24 inch cable tray has the capacity for additional future cables (1.93 inches or 2.25 sq. inches allowable fill can be used).

Notes:

1. This ratio is the inside width of the cable tray in inches divided by its maximum fill area in sq. inches from Column 1 Table 392.9.
2. The cable sizes used in this example are a random selection.
3. Cables - copper conductors with cross linked polyethylene insulation and a PVC jacket.
4. Total cable weight per foot for this installation.
40.2 lbs./ft. (Cables in this example do not contain equipment grounding conductors.)
This load can be supported by a load symbol "A" cable tray - 50 lbs./ft.

Example - NEC® Section 392.9(B)

Cable Tray containing Type ITC or Type PLTC Cables



50% of the cable tray useable cross sectional area can contain type PLTC cables

4 inches x 6 inches x .050 = 12 square inches allowable fill area.

2/C - #16 AWG 300 volt shielded instrumentation cable O.D. = 0.224 inches.

Cross Sectional Area = 0.04 square inches.

$$\frac{12 \text{ sq. in.}}{0.04 \text{ sq. in./cable}} = 300 \text{ cables can be installed in this cable tray.}$$

$$\frac{300 \text{ cables}}{26 \text{ cables/rows}} = 11.54 \text{ rows can be installed in this cable tray.}$$

Notes:

1. The cable sizes used in this example are a random selection.
2. Cables - copper conductors with PVC insulation, aluminum/mylar shielding, and PVC jacket.

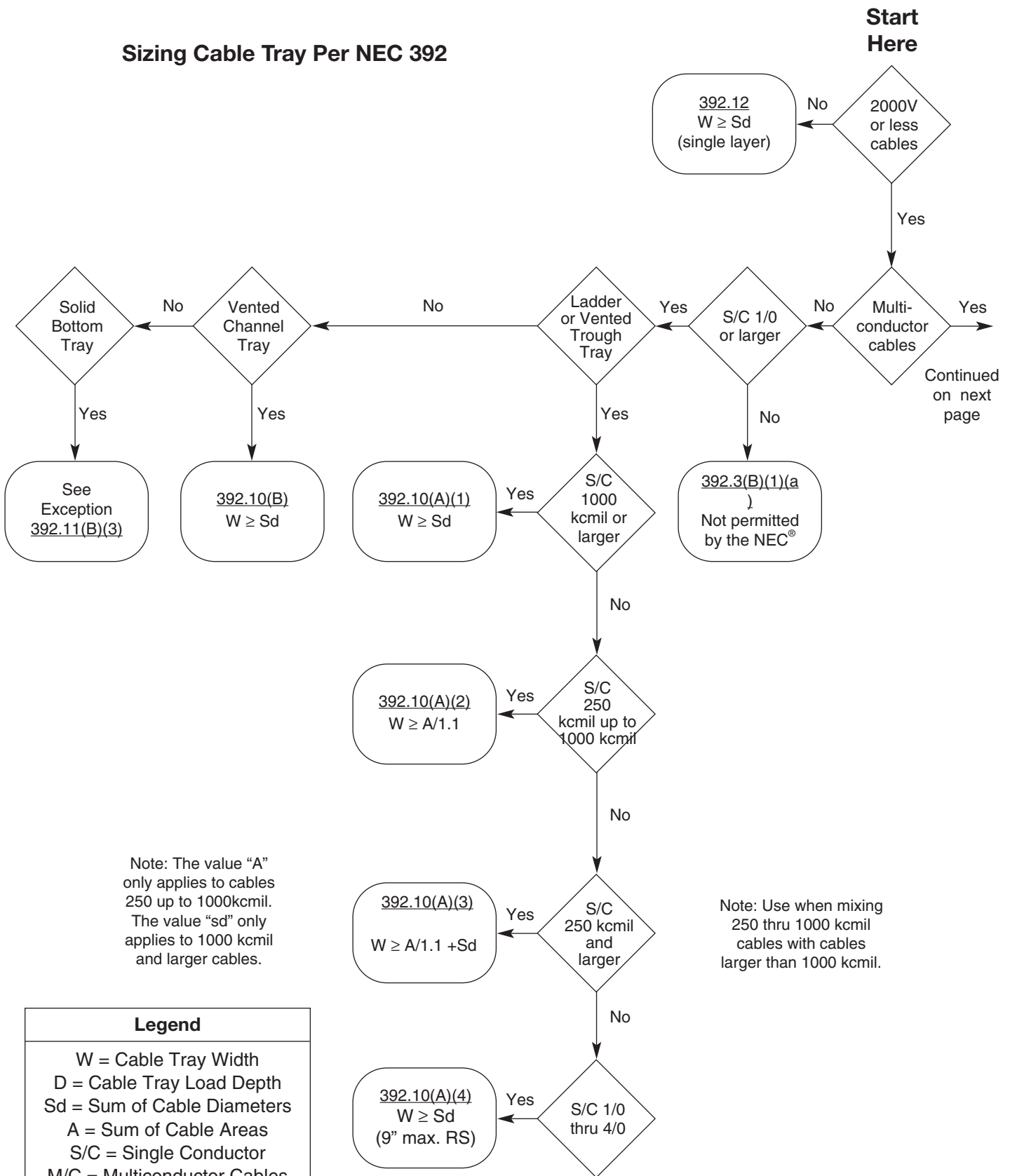
Table 250.122. Minimum Size Equipment Grounding Conductors for Grounding Raceways and Equipment

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

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CABLE TRAY SIZING FLOWCHART

Sizing Cable Tray Per NEC 392



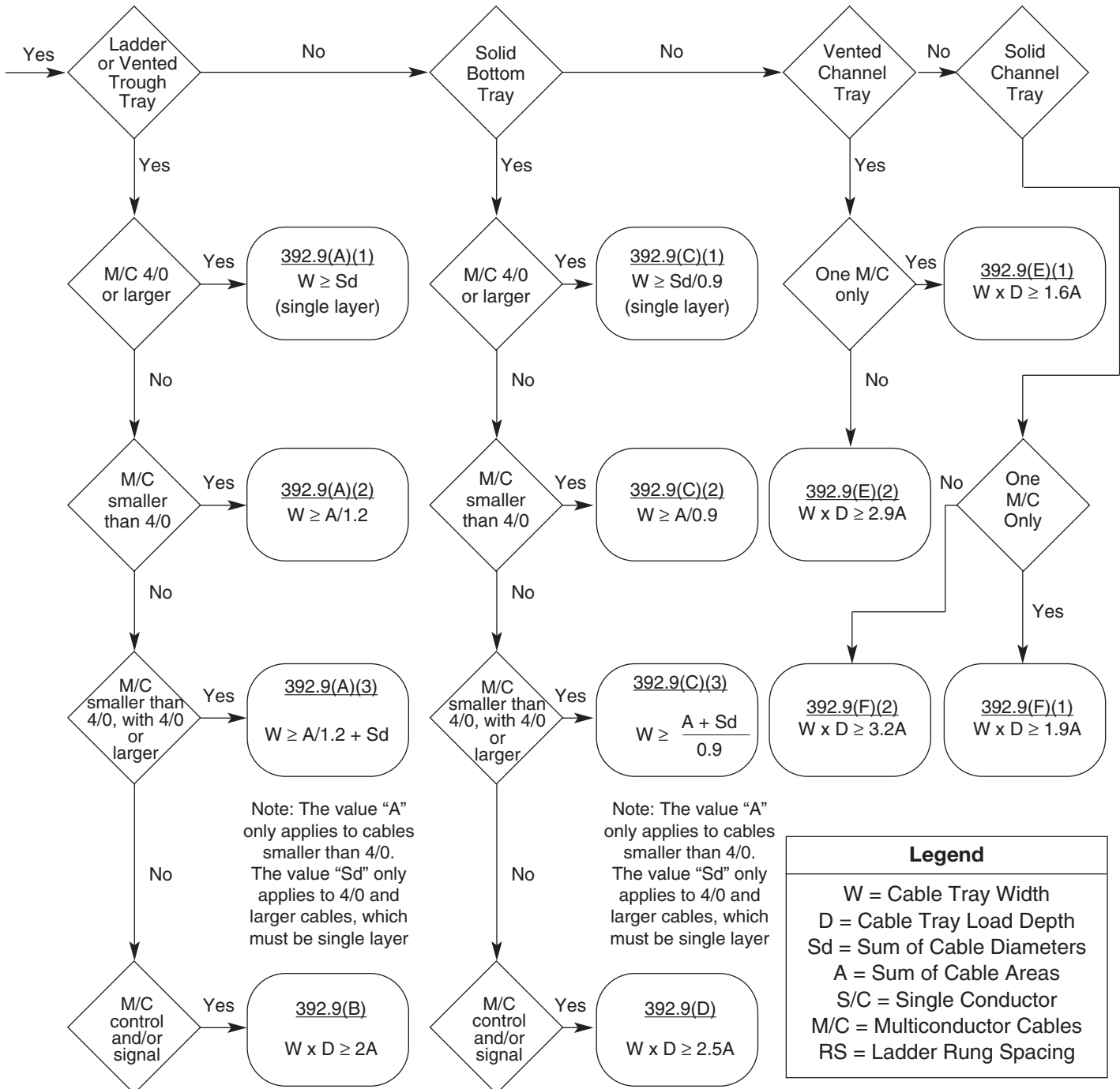
Legend

W = Cable Tray Width
 D = Cable Tray Load Depth
 Sd = Sum of Cable Diameters
 A = Sum of Cable Areas
 S/C = Single Conductor
 M/C = Multiconductor Cables
 RS = Ladder Rung Spacing

CABLE TRAY SIZING FLOWCHART

Ampacity: See pages 412 - 414 for information on cable ampacity that might affect the cable tray sizing flowchart.

See pages 393 - 396 for information on hazardous (classified) areas that might affect the cable tray sizing flowchart.



Note: The value "A" only applies to cables smaller than 4/0. The value "Sd" only applies to 4/0 and larger cables, which must be single layer

Note: The value "A" only applies to cables smaller than 4/0. The value "Sd" only applies to 4/0 and larger cables, which must be single layer

Legend	
W	= Cable Tray Width
D	= Cable Tray Load Depth
Sd	= Sum of Cable Diameters
A	= Sum of Cable Areas
S/C	= Single Conductor
M/C	= Multiconductor Cables
RS	= Ladder Rung Spacing

Appendix Sheet 8

Cable Tray Manual

CABLE TRAY INSTALLATION & SPECIFICATION CHECKLIST

Project Information

Project Name: _____ # _____
 Location: _____
 Contractor/Engineer: _____
 Phone: _____

Project Information

Distributor Name: _____
 Location: _____
 Contact: _____
 Phone: _____ Fax: _____

Cable Tray

<u>Material</u>	<u>NEMA Load Depth*</u>
Aluminum <input type="checkbox"/>	2" ** <input type="checkbox"/>
Pre-Galvanized Steel <input type="checkbox"/>	3" <input type="checkbox"/>
Hot-Dip Galvanized Steel <input type="checkbox"/>	4" <input type="checkbox"/>
304 Stainless Steel <input type="checkbox"/>	5" <input type="checkbox"/>
316 Stainless Steel <input type="checkbox"/>	6" <input type="checkbox"/>
Fiberglass-Polyester Resin <input type="checkbox"/>	
Fiberglass-Vinyl Ester Resin <input type="checkbox"/>	
Fiberglass-Zero Halogen <input type="checkbox"/>	
Fiberglass-Dis Stat <input type="checkbox"/>	

* Load depth is 1" less than siderail height.
 ** Fiberglass and wire mesh.

<u>Width</u>	<u>Bottom Styles</u>	<u>Length</u>	<u>Fitting Radius</u>
6" <input type="checkbox"/>	6" <input type="checkbox"/>	<u>Metallic</u>	12" <input type="checkbox"/>
9" <input type="checkbox"/>	9" <input type="checkbox"/>	120" <input type="checkbox"/>	24" <input type="checkbox"/>
12" <input type="checkbox"/>	12" <input type="checkbox"/>	144" <input type="checkbox"/>	36" <input type="checkbox"/>
18" <input type="checkbox"/>	18" <input type="checkbox"/>	240" <input type="checkbox"/>	48" <input type="checkbox"/>
24" <input type="checkbox"/>	Ventilated Trough <input type="checkbox"/>	288" <input type="checkbox"/>	
30" <input type="checkbox"/>	Non-Ventilated Trough <input type="checkbox"/>	<input type="checkbox"/>	
36" <input type="checkbox"/>	Non-Ventilated Bottom <input type="checkbox"/>	<u>Non-Metallic</u>	
42" <input type="checkbox"/>		120" <input type="checkbox"/>	
		240" <input type="checkbox"/>	

Tray Series

B-Line Series _____ OR _____

System Loading

(50 lbs./ft.)
 (75 lbs./ft.)
 (100 lbs./ft.)

Support Span _____ ft.
 Load Rating _____ lbs./ft.
 Safety Factor _____

CABLE TRAY INSTALLATION & SPECIFICATION CHECKLIST

Cable Channel			
<u>Material</u>		<u>Width</u>	
Aluminum	<input type="checkbox"/>	3"	<input type="checkbox"/>
Pre-Galvanized Steel	<input type="checkbox"/>	4"	<input type="checkbox"/>
Hot-Dip Galvanized Steel	<input type="checkbox"/>	6"	<input type="checkbox"/>
304 Stainless Steel	<input type="checkbox"/>	8" *	<input type="checkbox"/>
316 Stainless Steel	<input type="checkbox"/>	* Fiberglass only.	
Fiberglass-Polyester Resin	<input type="checkbox"/>	<u>Fitting Radius</u>	
Fiberglass-Vinyl Ester Resin	<input type="checkbox"/>	0"	<input type="checkbox"/>
Fiberglass-Zero Halogen	<input type="checkbox"/>	6"	<input type="checkbox"/>
Fiberglass-Dis Stat	<input type="checkbox"/>	12"	<input type="checkbox"/>
<u>Type</u>		24"	<input type="checkbox"/>
Ventilated	<input type="checkbox"/>	36"	<input type="checkbox"/>
Non-Ventilated	<input type="checkbox"/>		

Cent-R-Rail			
<u>System</u>		<u>Depth*</u>	
Data-Track	<input type="checkbox"/>	Straight Rung	<input type="checkbox"/>
Verti-Rack	<input type="checkbox"/>	2"	<input type="checkbox"/>
Half-Rack	<input type="checkbox"/>	3"	<input type="checkbox"/>
Multi-Tier Half Rack	<input type="checkbox"/>	4"	<input type="checkbox"/>
		6"	<input type="checkbox"/>
<u>Width*</u>	<u>Rung Spacing*</u>	<u>Tiers*</u>	<u>Length</u>
3" <input type="checkbox"/>	6" <input type="checkbox"/>	2 <input type="checkbox"/>	120" <input type="checkbox"/>
6" <input type="checkbox"/>	9" <input type="checkbox"/>	3 <input type="checkbox"/>	144" <input type="checkbox"/>
9" <input type="checkbox"/>	12" <input type="checkbox"/>	4 <input type="checkbox"/>	
12" <input type="checkbox"/>	18" <input type="checkbox"/>	5 <input type="checkbox"/>	
18" <input type="checkbox"/>	24" <input type="checkbox"/>	6 <input type="checkbox"/>	
24" <input type="checkbox"/>			

* Options shown are not available for all systems. Please check B-Line Cent-R-Rail Catalog for availability.

Flextray			
<u>Width*</u>	<u>Depth*</u>	<u>Wire Mesh Size</u>	<u>Length</u>
2" <input type="checkbox"/>	1.5" <input type="checkbox"/>	2 x 4	118" (3 meters)
4" <input type="checkbox"/>	2" <input type="checkbox"/>		
6" <input type="checkbox"/>	4" <input type="checkbox"/>		
8" <input type="checkbox"/>	6" <input type="checkbox"/>		
12" <input type="checkbox"/>			
16" <input type="checkbox"/>			
18" <input type="checkbox"/>			
20" <input type="checkbox"/>			
24" <input type="checkbox"/>			
30" <input type="checkbox"/>			
32" <input type="checkbox"/>			

* Widths shown are not available for all depths.

Footnotes:

- ¹ NEMA Standard VE-2, Section 4, Installation 4.3 Straight Section Installation - 4.3.1. Horizontal Cable Tray Straight Sections states that straight section lengths should be equal to or greater than the span length to ensure not more than one splice between supports.

Additional Cable Tray Resources

Cable Tray Institute
1300 N. 17th Street
Rosslyn, VA 22209

www.cabletrays.com

National Electrical Manufacturers Association
1300 N. 17th Street
Rosslyn, VA 22209

www.nema.org

B-Line Engineering Software

TrayCAD™

TrayCAD is a Cable Tray layout design program that works within the AutoCAD® environment. TrayCAD is a windows based program and installs as an add-on to your AutoCAD system. Use the TrayCAD toolbar to add cable tray to your existing plans by drawing a single centerline representation of the tray run. Then, with the click of a button, the program will build a full-scale 3-D wire-frame model of the cable tray and all the appropriate fittings. The program also automatically creates a Bill of Material and contains a library of modifiable details.

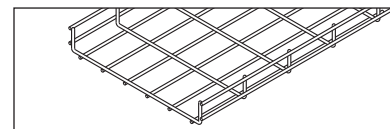
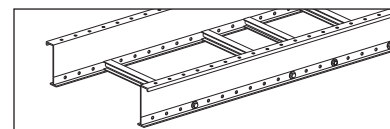
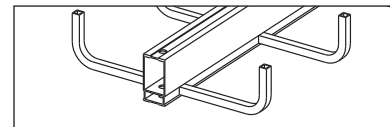
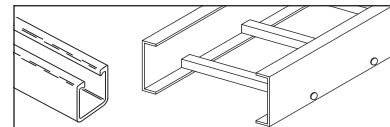
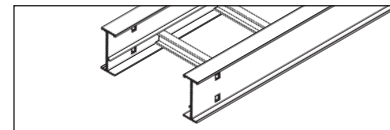
Runway Router™

Runway Router is a cable ladder runway (ladder rack) layout design program that works within your AutoCAD environment. Use the commands from the Runway Router toolbar to layout runway, relay racks and electronic cabinets. Add cable tray or Cent-R-Rail™ to your existing plans by drawing a single centerline representation of the cable run. Then, with the click of a button, the program will build a full-scale 3-D wire-frame model of the cable runway and all the appropriate connectors and fittings. The program also automatically creates a Bill of Material and contains a library of modifiable details.

B-Line Wire Management Resources

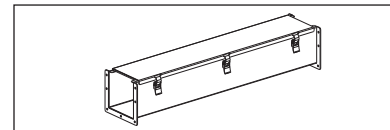
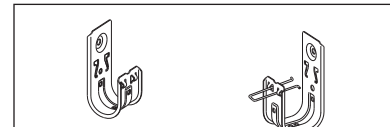
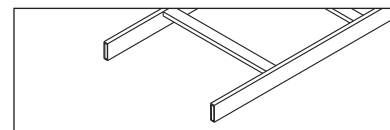
B-Line Product Catalogs

- Cable Tray Systems
 Metallic, Two Siderail System
 Commercial and Industrial Applications
- Fiberglass Cable Tray
 Non-Metallic, Two Siderail Trays
 Non-Metallic Strut Systems
- Cent-R-Rail™
 Center Supported Cable Tray
 “Lay-In” Cable Design for Easy Installation
 of Low Voltage Cables
- Redi-Rail™
 Pre-Punched Aluminum Side Rail Design
 Unmatched Job Site Adaptability for a Two
 Side Rail System - Load Depths 2” to 6”
- Flextray
 Unmatched Adaptability to Site Conditions
 Pre-Packaged Installation Kits and Accessories
 Fast - Adaptable - Economical



Other B-Line Wire Management Systems

- Telecom
 Saunders' Cable Runway and Relay Racks
 Unequal Flange Racks
- Cable Hooks
 Supports all Cat 5, Fiber Optic, Innerduct
 and Low Voltage Cabling Requirements
- Wireway
 Houses Runs of Control and Power Cable
 Available in NEMA 12, Type 1 & Type 3R



B-Line Mechanical Support Systems

- Strut Systems
 Metal Framing Support System. Fully Adjustable
 and Reusable, with a Complete Line of Channel,
 Fittings and Accessories for Multi-Purpose Applications
- Seismic Restraints
 Multi-Directional Bracing for Electrical Conduit,
 Cable Tray and Mechanical Piping Systems.
 OSHQP Pre-Approved Details

