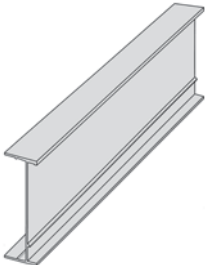
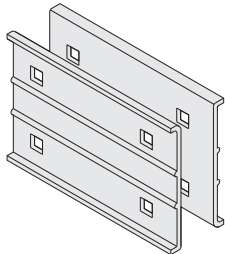
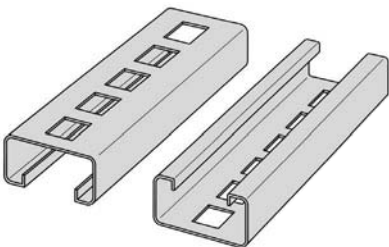
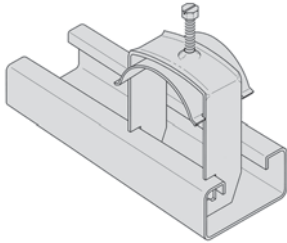
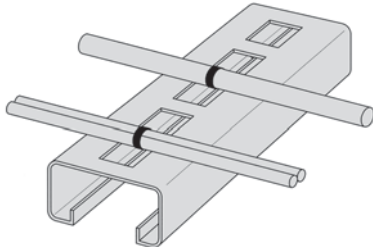
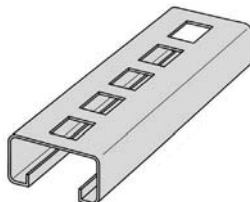
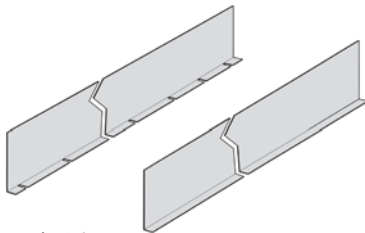


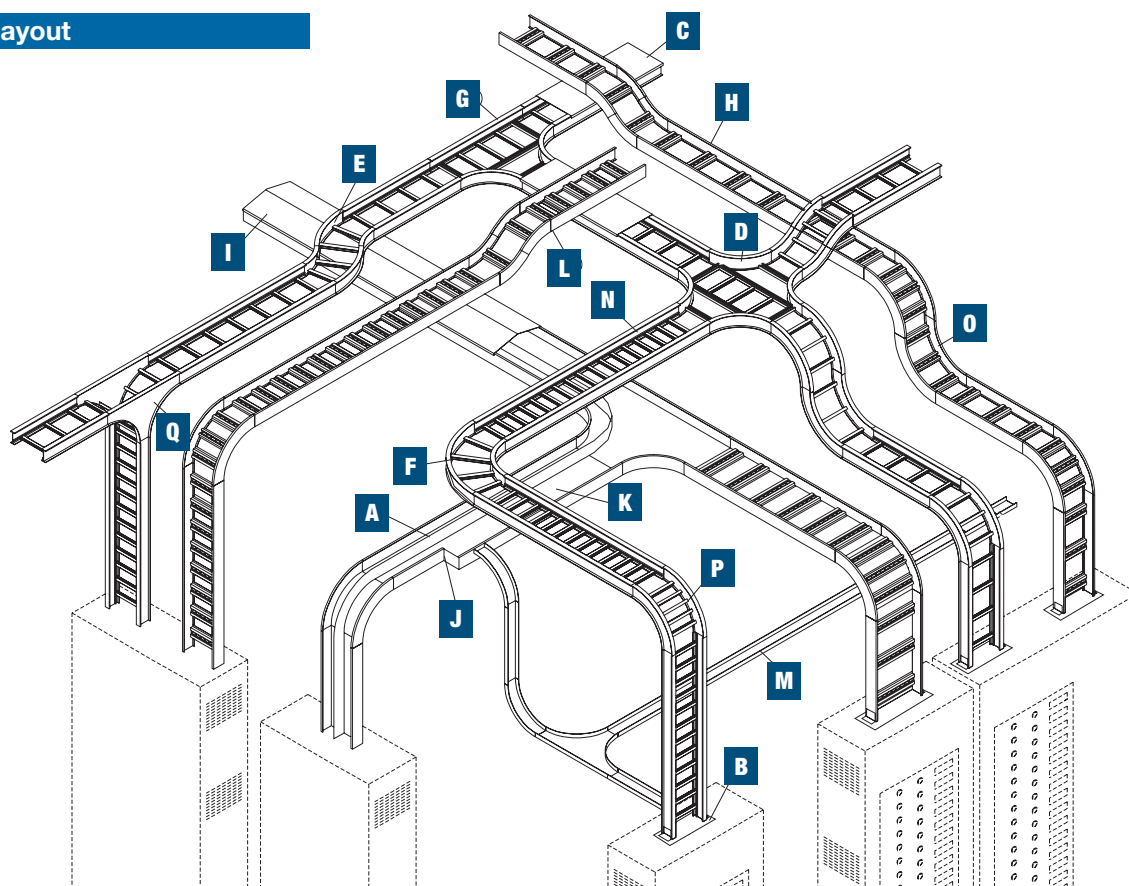
## Glossary of Terms

<b>Accessories.....</b>	Devices which are used to supplement the function of straight sections and fittings, and include such items as drop outs, covers, conduit adapters, hold-down devices and dividers.
<b>Cable Tray Connector .....</b>	A device which joins cable tray straight sections or fittings, or both. The basic types of connectors are: 1. Rigid, 2. Expansion, 3. Adjustable, 4. Reducer.
<b>Cable Tray Fitting.....</b>	A device which is used to change the direction, elevation or width of a cable tray system.
<b>Cable Tray Support .....</b>	A device which provides adequate means for supporting cable tray sections or fittings, or both. The basic types of cable tray supports are: 1. Cantilever bracket, 2. Trapeze, 3. Individual and suspension.
<b>Channel Cable Tray.....</b>	A prefabricated metal structure consisting of a one-piece ventilated bottom or solid bottom channel section, or both, not exceeding 6 inches in width.
<b>Ladder Cable Tray.....</b>	A prefabricated metal structure consisting of two longitudinal side rails connected by individual transverse members.
<b>Solid Bottom Cable Tray .....</b>	A prefabricated metal structure consisting of a bottom with no openings within integral or separate longitudinal side rails.
<b>One-Piece / Unit Cable Tray.....</b>	A prefabricated metal structure consisting of a one-piece solid or ventilated bottom.
<b>Horizontal Cross .....</b>	A cable tray fitting which is suitable for joining cable trays in four directions at 90-degree intervals in the same plane.
<b>Horizontal Bend .....</b>	A cable tray fitting which changes the direction in the same plane.
<b>Horizontal Tee .....</b>	A cable tray fitting which is suitable for joining cable trays in three directions at 90 degree intervals in the same plane.
<b>Metallic Cable Tray System .....</b>	A metallic assembly of cable tray straight sections, fittings, and accessories that forms a rigid structural system to support cables.
<b>Reducer .....</b>	A cable tray fitting which is suitable for joining cable trays of different widths in the same plane. A straight reducer has two symmetrical offset sides. A right-hand reducer, when viewed from the large end, has a straight side on the right. A left-hand reducer, when viewed from the large end, has a straight side on the left.
<b>Straight Section .....</b>	A length of cable tray which has no change in direction or size.
<b>Ventilated Bottom.....</b>	A cable tray bottom having openings sufficient for the passage of air and utilizing 75% or less of the plan area of the surface to support cables.
<b>Vertical Bend.....</b>	A cable tray fitting which changes direction to a different plane. An inside vertical elbow changes direction upward from the horizontal plane. An outside vertical elbow changes direction downward from the horizontal plane.

### Unique Design Features

<b>I-Beam Side Rail (Aluminum)</b>  Maximum structural strength		<b>Snap-in Splice Plates (Aluminum)</b>  Snap-in aluminum splice plates for easy installation	
<b>Alternating Rungs (Aluminum &amp; Steel)</b>  Alternating rungs for top and bottom accessory installation and cable lashing		<b>Continuous Open Slot (Aluminum &amp; Steel)</b>  Rungs have continuous open slot to accept standard strut pipe clamps and provide complete barrier strip adjustability	
<b>Ty-Rap® Cable Tie Slots (Aluminum &amp; Steel)</b>  Exclusive Ty-Rap® cable tie slots 1 in. center to center on all ladder ventilated and solid bottoms. Secure cables without kinks and keeps cables uniform		<b>Added Support (Aluminum &amp; Steel)</b>  Aluminum and steel solid bottoms are constructed with a flat sheet for added cable protection	
<b>Extra Wide Rung Design (Aluminum &amp; Steel)</b>  Extra wide rung design for maximum cable bearing surface		<b>Adjustable Barrier Strips (Aluminum &amp; Steel)</b>  Barrier strips are fully adjustable (side to side) for use in straight sections and fittings	 <div> 1.5 m / 72 in. 3 m / 144 in. </div>

### Sample Plant Layout



### Application

COMMERCIAL	INDUSTRIAL
Schools	Petrochemical Plants
Hospitals	Automotive Plants
Office Buildings	Paper Plants
Airports	Food Processing
Casinos	Power Plants
Stadiums	Refineries
	Manufacturing
	Mining

### Legend

A	Barrier Strip	J	Right Reducer
B	Box Connector	K	Solid Tray
C	Flat Cover	L	Splice Connector
D	Horizontal Cross	M	Solid Channel Tray
E	Horizontal 45°	N	Ventilated Tray
F	Horizontal 90°	O	Vertical 90° Inside
G	Horizontal Tee	P	Vertical 90° Outside
H	Ladder Tray	Q	Vertical Tee
I	Peaked Cover		

### Selection Process

.....

A number of basic decisions must be made before a cable tray system can be specified. Thomas & Betts has developed a simple eight-step process to guide you in the process:

1. Select material and finish (p. A8)
2. Select the tray load class (p. A16)
3. Select the tray type (p. A23)
4. Select the tray size (p. A23)
5. Select the fittings (p. A24)
6. Consider deflection (p. A25)
7. Consider thermal expansion & contraction (p. A28)
8. Electrical grounding capacity (p. A29)

Each step is described in detail in the following pages. For many applications, however, you may also have to take the following into account:

- Weight of the installation, which affects the cost of the support structure and the ease of installation.
- Corrosion resistance of the material is one of the most important selection criteria. Cable tray materials may not respond the same way in different environments. Chemicals or combinations of chemicals have a corrosive effect on some materials that can be compounded by temperature or even the speed at which the corrosive elements contact the cable tray. For example, some grades of stainless steel may be resistant to salt water at high flow rates (perfect for heat exchangers), while exhibiting some corrosion pitting in standing salt water. Only the designer can quantify the various elements that affect the corrosion resistance of the cable tray system in a specific application. While Thomas & Betts can provide guidance, the designer is responsible for the final selection. For more information, see “Corrosion” section.
- Melting point and flammability rating are primarily concerns for nonmetallic tray. Local building codes may restrict the use of a given product if certain performance levels are not met. Check with the appropriate inspection authorities before specifying the product.
- Relative cost varies dramatically, including material costs that float with the commodity index. For example, stainless steel prices may vary significantly according to daily changes in the market.

## 1. Select Material and Finish

The most suitable material and finish for your application will depend on cost, the potential for corrosion, and electrical considerations. Thomas & Betts offers cable tray systems fabricated from corrosion-resistant steel, stainless steel and aluminum alloys along with corrosion-resistant finishes, including zinc, and epoxy. Special paint is also available.

### Materials

Most cable tray systems are fabricated from a corrosion-resistant metal (stainless steel or an aluminum alloy) or from a metal with a corrosion-resistant finish (zinc or epoxy). The choice of material for any particular installation depends on the installation environment (corrosion and electrical considerations) and cost.

#### Aluminum

Cable trays fabricated of extruded aluminum are often used for their high strength-to-weight ratio, superior resistance to certain corrosive environments, and ease of installation. They also offer the advantages of being light weight (approximately less than 50% that of a steel tray) and maintenance free and since aluminum cable trays are non-magnetic, electrical losses are reduced to a minimum.

T&B® Cable Tray products are formed from the 6063 series alloys which by design are copper free alloys for marine applications. These alloys contain silicon and magnesium in appropriate proportions to form magnesium silicide, allowing them to be heat treated. These magnesium silicon alloys possess good formability and structural properties, as well as excellent corrosion resistance.

The unusual resistance to corrosion, including weathering, exhibited by aluminum is due to the self-healing aluminum oxide film that protects the surface. Aluminum's resistance to chemicals in the application environment should be tested before installation.

#### Steel

Thomas & Betts steel cable trays are fabricated from structural quality steels using a continuous roll-formed process. Forming and extrusions increase the mechanical strength.

The main benefits of steel cable tray are its high strength and low cost.

The rate of corrosion will vary depending on many factors such as the environment, coating or protection applied and the composition of the steel. Thomas & Betts offers finishes and coatings to improve the corrosion resistance of steel. These include pregalvanized, hot dip galvanized (after fabrication), epoxy and special paints.

#### Stainless Steel

Stainless steel offers high yield strength and high creep strength, at high ambient temperatures.

Thomas & Betts stainless steel cable tray is roll-formed from AISI Type 316/316L stainless steel.

Stainless steel is resistant to dyestuffs, organic chemicals, and inorganic chemicals at elevated temperatures. Higher levels of chromium and nickel and a reduced level of carbon serve to increase corrosion resistance and facilitate welding. Type 316 includes molybdenum to increase high temperature strength and improve corrosion resistance, especially to chloride and sulfuric acid.

### 1. Select Material and Finish (cont'd)

#### Finishes

##### Electrogalvanized Coatings

The most widely used coating for cable tray is galvanizing. It is cost-effective, protects against a wide variety of environmental chemicals, and is self-healing if an area becomes unprotected through cuts or scratches.

Steel is coated with zinc through electrolysis by dipping steel into a bath of zinc salts. A combination of carbonates, hydroxides and zinc oxides forms a protective film to protect the zinc itself. Resistance to corrosion is directly related to the thickness of the coating and the harshness of the environment.

##### Pregalvanized

Pregalvanized, also known as mill-galvanized or hot dip mill-galvanized, is produced in a rolling mill by passing steel coils through molten zinc. These coils are then slit to size and fabricated.

Areas not normally coated during fabrication, such as cuts and welds, are protected by neighboring zinc, which works as a sacrificial anode. During welding, a small area directly affected by heat is also left bare, but the same self-healing process occurs.

G90 requires a coating of .90 ounces of zinc per square foot of steel, or .32 ounces per square foot on each side of the metal sheet. In accordance with A653/A653M-06a, pregalvanized steel is not generally recommended for outdoor use or in industrial environments.

##### Hot-Dipped Galvanized

After the steel cable tray has been manufactured and assembled, the entire tray is immersed in a bath of molten zinc, resulting in a coating of all surfaces, as well as all edges, holes and welds.

Coating thickness is determined by the length of time each part is immersed in the bath and the speed of removal.

Hot dip galvanizing after fabrication creates a much thicker coating than the pregalvanized and electrogalvanized process, a minimum of 3.0 ounces per square foot of steel or 1.50 ounces per square foot on each side of the sheet (according to ASTM A123, grade 65).

The process is recommended for cable tray used in most outdoor environments and many harsh industrial environment applications.

##### Other Coatings

Epoxy and special paint coatings are available on request.

## 1. Select Material and Finish (cont'd)

Corrosion of metal occurs naturally when the metal is exposed to chemical or electrochemical attack. The atoms on the exposed surface of the metal come into contact with a substance, leading to deterioration of the metal through a chemical or electrochemical reaction. The corroding medium can be a liquid, gas or solid.

Although all metals are susceptible to corrosion, they corrode in different ways and at various speeds. Pure aluminum, bronze, brass, most stainless steels and zinc corrode relatively slowly, but some aluminum alloys, structural grades of iron and steel and the 400 series of stainless steels corrode quickly unless protected.

### Electrochemical Corrosion

Electrochemical corrosion is caused by an electrical current flow between two dissimilar metals, or if a difference of potential exists, between two areas of the same metal surface.

The energy flow occurs only in the presence of an electrolyte, a moist conductor that contains ions, which carry an electric charge. Solutions of acids, alkalies, and salts contain ions, making water—especially salt water—an excellent electrolyte.

#### Common Types of Corrosion

##### Galvanic Corrosion

Galvanic corrosion results from the electrochemical reaction that occurs in the presence of an electrolyte when two dissimilar metals are in contact. The strength of the reaction and the extent of the corrosion depend on a number of factors, including the conductivity of the electrolyte and potential difference of the metals.

The metal with less resistance becomes anodic and more subject to corrosion, while the more resistant becomes cathodic.

The Galvanic Series Table, developed through laboratory tests on industrial metal alloys in sea water (a powerful electrolyte), list metals according to their relative resistance to galvanic corrosion. Those less resistant to galvanic corrosion (anodic) are at the top, and those more resistant (cathodic) are at the bottom.

The metals grouped together are subject to only slight galvanic effect when in contact, and metals at the top will suffer galvanic corrosion when in contact with metals at the bottom (in the presence of an electrolyte). The farther apart two metals are on the table, the greater the potential corrosion.

#### Galvanic Series Table

Anodic End	
1. Magnesium	25. 50Pb-50Sn solder
2. Magnesium alloys	26. Silver (passive)
3. Zinc	27. Type 304 stainless steel (active)
4. Galvanized steel	28. Type 316 stainless steel (active)
5. Naval brass (C46400)	29. Lead
6. Aluminum 5052H	30. Tin
7. Aluminum 3004	31. Muntz metal (C28000)
8. Aluminum 3003	32. Manganese bronze (C67500)
9. Aluminum 1100	33. Nickel (active)
10. Aluminum 6053	34. Inconel (active)
11. Alclad aluminum alloys	35. Cartridge brass (C26000)
12. Aluminum bronze (C61400)	36. Admiralty metal (C44300)
13. Cadmium	37. Red brass (C23000)
14. Copper (C11000)	38. Silicon bronze (C 65100)
15. Aluminum 2017	39. Copper nickel, 30% (C71500)
16. Aluminum 2024	40. Nickel (passive)
17. Low-carbon steel	41. Inconel (passive)
18. Wrought iron	42. Gold
19. Cast iron	43. Platinum
20. Monel	
21. Ni-resist	
22. Type 304 stainless steel (passive)	
23. Type 410 stainless steel (passive)	
24. Type 316 stainless steel (passive)	Cathodic End



### 1. Select Material and Finish (cont'd)

.....

#### Pitting Corrosion

Pitting corrosion is localized and is identified by a cavity with a depth equal to or greater than the cavity's surface diameter. Pits may have different sizes and depths and most often appear randomly distributed. Aluminum and stainless steels in chloride environments are especially susceptible to pitting.

Pitting begins when surface defects, foreign particles or other variations in the metal lead to fixation of anodic (corroded) and cathodic (protected) sites on the metal surface. Acidic metal chlorides, which form and accumulate in the pit as a result of anodes attracting chloride ions, accelerate the pitting process over time. The nature of pitting often makes it difficult to estimate the amount of damage.

#### Crevice Corrosion

Crevice corrosion is a specialized form of pitting that particularly attacks metals or alloys protected by oxide films or passive layers. It results from a relative lack of oxygen in a crevice, with the metal in the crevice becoming anodic to the metal outside. For the crevice to corrode, it must be large enough to admit the electrolyte, but small enough to suffer oxygen depletion.

#### Erosion Corrosion

While erosion is a purely mechanical process, erosion corrosion combines mechanical erosion with chemical or electrochemical reaction. The process is accelerated by the generally rapid flow of liquid or gas over an eroded metal surface, removing dissolved ions and solid particles. As a result, the metal surface develops grooves, gullies, waves, rounded holes and valleys.

Erosion corrosion can damage most metals, especially soft ones like aluminum that are susceptible to mechanical wear, and those that depend for protection on a passive surface film, which can be eroded. Resulting damage can also be enhanced by particles or gas bubbles in a suspended state.

#### Intergranular Corrosion

Intergranular corrosion occurs between the crystals (or grains) that formed when the metal solidified. The composition of the areas between the crystals differs from that of the crystals themselves, and these boundary areas can become subject to intergranular corrosion. Weld areas of austenitic stainless steels are often affected by this form of corrosion, and the heat-treatable aluminum alloys are also susceptible.



## 1. Select Material and Finish (cont'd)

### Corrosion Resistance Guide

The following table has been compiled as a guide for selecting appropriate cable trays for various industrial environments. The information can only be used as a guide because corrosion processes are dictated by the unique circumstances of any particular assembly.

Corrosion is significantly affected by trace impurities which, at times, can become concentrated through wet/dry cycles in locations that are prone to condensation and evaporation. It is not uncommon to find aggressive mists created from contaminant species, notably from sulfur or halogen sources.

Temperature greatly influences corrosion, sometimes increasing the rate of metal loss, (a rule-of-thumb guide is that a 30°C change in temperature results in a 10X change in corrosion rate). Sometimes corrosion attack slows down at higher temperatures because oxygen levels in aqueous solutions are lowered as temperatures increase. If an environment completely dries out then there can be no corrosion.

Stress-associated corrosion might occur when assemblies are poorly installed and/or fabricated, e.g., on-site welding or mechanical fastening. Premature failure can result from: corrosion fatigue, which can occur in any environment; stress corrosion cracking, which occurs in the presence of a specific chemical when the metal is under a tensile stress, which may be residual or applied, (e.g., from poor fabrication or welding); fretting, where two adjacent surfaces (under load) are subjected to an oscillatory motion across the mating surfaces.

Design should minimize the risk of stress concentrations within a structure. Examples include sharp profiles, abrupt section changes, and threaded screws. These measures are particularly important for metals that are prone to stress corrosion cracking in specific media. Design plays a significant role in exacerbating corrosion. Non-draining locations create liquid traps; local metal-to-metal (or metal-to-non-metal) contact points (e.g., mechanical assembly bolts with washers or spacers), permit crevice corrosion and/or galvanic corrosion to occur. Areas that are poorly maintained, (e.g., surfaces are not regularly or properly washed and stubborn deposits remain on the metal surface), are particularly prone to localized corrosion damage due to different levels of oxygen under and adjacent to the location in question (differential aeration). Resulting damage from these situations is in the form of small holes (pits). In each of the examples just quoted there is a restricted supply of oxygen. Thus, metals (e.g., aluminum, stainless steels, zinc) that rely on oxygen to form protective corrosion films (oxides, hydroxides, carbonates, etc.) may be prone to localized pitting and/or crevice corrosion.

A further example of localized corrosion occurs when dissimilar metals contact each other in the presence of a corrodent, i.e., galvanic corrosion. Each metal will corrode but the one that is most active [anode] can be more corroded especially when there is a large surrounding area of the less active [cathodic] metal. It is wise to avoid small anodic areas. Some examples include: steel bolts [small area of anodic metal] in stainless steel plate, [large area of cathodic metal]; steel bolts in copper plate - the steel corrodes. There can be environmental influences, for example a fluid that contains active metallic species, like copper ion contact with aluminum (copper picked up from aqueous solutions conveyed in copper pipe) - the aluminum corrodes. A further dramatic example is provided when trace quantities of mercury contact aluminum - the aluminum corrodes very rapidly. These are examples of deposit corrosion.

## 1. Select Material and Finish (cont'd)

### Corrosion Resistance Guide (cont'd)

This guide provides an indication of the suitability of a potential candidate material for a specific chemical environment. These tables should be regarded only as a GUIDE to anticipated performance because of possible contributions from temperature, pollutant (contaminant) species, etc.

Chemical Species	Aluminum	HDG/Steel	316SS
Acetaldehyde	++	+	++
Acetic acid - aerated	(+) <sup>TC</sup>	X	(++) <sup>T</sup>
Acetone	++	++	++
Acetylene	++	nd	++
Allyl alcohol	+	nd	++
Aluminum chloride - dry	+	nd	(+) <sup>TP</sup>
Aluminum chloride - wet	X	X	(-) <sup>P</sup>
Aluminum sulfate - satd.	X	nd	+
Ammonia - anhydrous	++	++	++
Ammonia - gas	-	+	(+) <sup>T</sup>
Ammonium acetate	+	nd	+
Ammonium bicarbonate	-	nd	(+) <sup>T</sup>
Ammonium carbonate - satd.	+	X	+
Ammonium chloride - 28%	X	X	(+) <sup>PS</sup>
Ammonium chloride - 50%	X	X	X
Ammonium hydroxide	+	+	(++) <sup>C</sup>
Ammonium chloride - 28%	X	X	(+) <sup>PS</sup>
Ammonium chloride - 50%	X	X	X
Ammonium hydroxide	+	+	(++) <sup>C</sup>
Ammonium nitrate	+	X	(++) <sup>S</sup>
Ammonium phosphate - 40%	X	nd	+
Ammonium sulfate - to 30%	X	-	+
Amyl acetate	++	++	++
Asphalt	++	+	+
Beer	++	X	++
Benzene (benzol)	++	+	(+) <sup>P</sup>
Benzoic acid	+	nd	+
Benzol - see benzene			
Boric acid (boracic acid)	++	nd	(++) <sup>TP</sup>
Bromine - wet	X	X	X
Butadiene (butylene)	+	+	+
Butyl alcohol (butanol)	++	++	++
Butyric acid	+	X	+
Cadmium sulfate	+	nd	++
Calcium carbonate	-	nd	+
Calcium chloride - satd.	+	X	(+) <sup>S</sup>
Calcium hydroxide - satd.	X	nd	+

Chemical Species	Aluminum	HDG/Steel	316SS
Calcium hypochlorite - satd.	X	X	(-) <sup>P</sup>
Carbon dioxide - wet	++	+	+
Carbon disulfide (bisulfide)	++	+	++
Carbon tetrachloride	X	+	(++) <sup>PS</sup>
Carbolic acid - see phenol			
Carbonic acid - see carbon dioxide			
Caustic potash - see potassium hydroxide			
Caustic soda - see sodium hydroxide			
Chlorine gas - wet	X	++	(-) <sup>PS</sup>
Chloroform	(+) <sup>dry</sup>	+	(+) <sup>TS</sup>
Chromic acid	+	nd	(+) <sup>P</sup>
Citric acid - dilute	(+) <sup>TC</sup>	X	(++) <sup>P</sup>
Copper chloride	X	X	(-) <sup>P</sup>
Copper nitrate	X	nd	++
Copper sulfate	X	-	+
Cresol	+	+	+
Crude oil	++	++	++
Diethylamine	+	++	++
Dimethyl ketone - see acetone			
Ethyl acetate	(++) <sup>dry</sup>	++	+
Ethyl alcohol (ethanol)	++	++	++
Ethylene dichloride	(-) <sup>dry</sup>	++	(+) <sup>PS</sup>
Ethylene glycol (glycol)	++	++	++
Ferric chloride	X	X	X
Ferric nitrate - 10%	X	nd	+
Ferrous sulfate	+	nd	(+) <sup>P</sup>
Formaldehyde (methanal)	(+) <sup>P</sup>	++	(++) <sup>TC</sup>
Fluorine gas - moist	X	X	X
Formalin - see formaldehyde			
Formic acid (methanoic acid) - 10%	(+) <sup>T</sup>	X	(+) <sup>PC</sup>
Furfural (furfuraldehyde)	+	nd	+
Furol - see furfural			
Gelatin	++	+	++
Glycerine (glycerol)	++	++	++
Hexamine - 80%	++	nd	++

#### SYMBOLS:

- ++** first choice; very low corrosion rate, typically <5 mpy, or <0.005 inch/year, (1 mil = 1/1000 inch)
- +** good choice; low corrosion rate, typically <20 mpy, or <0.02 ipy
- can use; corrosion rate up to 50 mpy (0.05 ipy); some limitations may apply
- X** not recommended
- (-)** brackets indicate probable limitations, e.g., at higher temperatures, [symbol "T"]; at higher concentrations, [symbol "C"]; due to pitting, [symbol "P"]; due to local grain boundary attack in the metal - intergranular corrosion, [symbol "I"]; or, due to stress corrosion cracking, [symbol "S"]
- nd** no available data

## 1. Select Material and Finish (cont'd)

### Corrosion Resistance Guide (cont'd)

This guide provides an indication of the suitability of a potential candidate material for a specific chemical environment. These tables should be regarded only as a GUIDE to anticipated performance because of possible contributions from temperature, pollutant (contaminant) species, etc.

Chemical Species	Aluminum	HDG/Steel	316SS
Hydrobromic acid	X	X	X
Hydrochloric acid (muriatic acid)	X	X	X
Hydrocyanic acid - dilute	+	nd	+
Hydrocyanic acid - conc	X	nd	+
Hydrofluoric acid	X	X	X
Hydrogen chloride gas - dry	X	X	(++) <sup>S</sup>
Hydrogen chloride gas - wet	X	X	+
Hydrogen fluoride	(-) <sup>T</sup>	nd	+
Hydrogen peroxide - to 40%	++	nd	+
Hydrogen sulfide - wet	(+) <sup>P</sup>	nd	(+) <sup>PS</sup>
Hypo - see sodium thiosulfate			
Hypochlorous acid	X	X	X
Iodine solution - satd.	X	X	X
Lactic acid	(+) <sup>T</sup>	nd	(+) <sup>PI</sup>
Latex	++	-	++
Lithium chloride - to 30%	X	nd	++
Linseed oil	+	nd	++
Magnesium chloride - 50%	X	X	(+) <sup>PS</sup>
Magnesium hydroxide	+	nd	++
Magnesium sulfate	+	X	+
Maleic acid (maleinic acid) - 20%	+	nd	+
Methyl alcohol (methanol)	++	++	++
Methyl ethyl ketone	+	++	+
Milk	++	X	++
Molasses	+	nd	++
Naptha	+	+	+
Natural fats	++	++	++
Nickel chloride	X	nd	(+) <sup>PS</sup>
Nickel sulfate	X	nd	+
Nitric acid	X	X	(++) <sup>I</sup>
Oleic acid	(++) <sup>T</sup>	nd	++
Oxalic acid - dilute	-	nd	+
Oxalic acid - saturated	(+) <sup>T</sup>	X	X
Paraformaldehyde - to 30%	+	nd	++
Perchloroethylene	+	X	(++) <sup>P</sup>
Phenol (carbolic acid)	+	+	++
Phosphoric acid - dilute	X	X	++

Chemical Species	Aluminum	HDG/Steel	316SS
Phosphoric acid - 50%	X	X	(++) <sup>I</sup>
Picric acid	++	nd	+
Potassium bicarbonate - 30%	X	nd	++
Potassium carbonate	X	nd	++
Potassium chloride - to 25%	X	X	(++) <sup>P</sup>
Potassium dichromate - 30%	(++) <sup>T</sup>	X	++
Potassium hydroxide	X	nd	(+) <sup>S</sup>
Potassium nitrate	++	++	+
Potassium sulfate	++	++	++
Propionic acid (propanoic acid)	(+) <sup>T</sup>	X	(+) <sup>T</sup>
Propyl alcohol (propane)	++	++	++
Prussic acid - see hydrocyanic acid			
Pyridine	+	nd	++
Soaps	+	-	+
Sodium bicarbonate - 20%	+	nd	++
Sodium bisulfate	X	X	(+) <sup>T</sup>
Sodium bisulfite	X	X	+
Sodium chloride - to 30%	X	X	(+) <sup>PS</sup>
Sodium cyanide	X	nd	(+) <sup>T</sup>
Sodium hydroxide - 10-30%	X	X	(+) <sup>S</sup>
Sodium hydroxide - 50%	X	X	(++) <sup>S</sup>
Sodium hydroxide - conc	X	X	++
Sodium hypochlorite - conc	X	+	(-) <sup>PS</sup>

#### SYMBOLS:

- ++** First choice; very low corrosion rate, typically <5 mpy, or <0.005 inch/year, (1 mil = 1/1000 inch)
- +** Good choice; low corrosion rate, typically <20 mpy, or <0.02 ipy
- Can use; corrosion rate up to 50 mpy (0.05 ipy); some limitations may apply
- X** Not recommended
- (-)** Brackets indicate probable limitations, e.g., at higher temperatures, [symbol "T"]; at higher concentrations, [symbol "C"]; due to pitting, [symbol "P"]; due to local grain boundary attack in the metal - intergranular corrosion, [symbol "I"]; or, due to stress corrosion cracking, [symbol "S"]
- nd** No available data

## 1. Select Material and Finish (cont'd)

### Corrosion Resistance Guide (cont'd)

This guide provides an indication of the suitability of a potential candidate material for a specific chemical environment. These tables should be regarded only as a GUIDE to anticipated performance because of possible contributions from temperature, pollutant (contaminant) species, etc.

Chemical Species	Aluminum	HDG/Steel	316SS
Sodium nitrate	++	X	++
Sodium peroxide - 10%	+	nd	+
Sodium silicate	++	nd	++
Sodium sulfate	(++) <sup>30%</sup>	X	++
Sodium sulfide - to 50%	X	nd	(+) <sup>T</sup>
Sodium thiosulfate	+	nd	+
Steam	(+) <sup>P</sup>	++	++
Stearic acid	+	nd	++
Sorbital (hexahydric alcohol)	++	+	++
Sulfur dioxide - dry	+	+	++
Sulfur dioxide - wet	X	X	(+) <sup>T</sup>
Sulfuric acid - to 80%	X	X	X
Sulfuric acid - 80-90%	X	X	(-) <sup>I</sup>
Sulfuric acid - 98%	X	X	(+) <sup>I</sup>
Tannic acid (tannin)	X	X	+
Tartaric acid - to 50%	(+) <sup>T</sup>	nd	++
Toluene (Toluol; methyl benzene)	++	++	++
Trichloroethylene	(++) <sup>T</sup>	+	(+) <sup>P</sup>
Turpentine	+	++	++
Water - acid, mine	X	-	(++) <sup>P</sup>
Water - potable	+	+	++
Water - sea	+	+	++
Zinc chloride - dilute	++	nd	(++) <sup>PS</sup>

#### SYMBOLS:

- ++** First choice; very low corrosion rate, typically <5 mpy, or <0.005 inch/year, (1 mil = 1/1000 inch)
- +** Good choice; low corrosion rate, typically <20 mpy, or <0.02 ipy
- Can use; corrosion rate up to 50 mpy (0.05 ipy); some limitations may apply
- X** Not recommended
- (-)** Brackets indicate probable limitations, e.g., at higher temperatures, [symbol "T"]; at higher concentrations, [symbol "C"]; due to pitting, [symbol "P"]; due to local grain boundary attack in the metal - intergranular corrosion, [symbol "I"]; or, due to stress corrosion cracking, [symbol "S"]
- nd** No available data

## 2. Select the Tray Class / Load Capacity (Loading)

### Selection Process

The standard classes of cable trays, as related to their maximum design loads and to the associated design support spacing based on a simple beam span requirement, shall be designated in accordance with Table 1. Please note the load ratings in Table 1 are those most commonly used. Other load ratings are acceptable. (according to NEMA VE-1 / CSA C22.2 No 126.1-02).

Costs vary between different load classes. Since labor and coupling costs are similar for a given length of tray, the heavier classes are less cost-effective on a load length basis. The designer should therefore specify the lightest class of tray compatible with the weight requirements of the cable tray.

**Table 1**

Span/Load Class Designation — USA

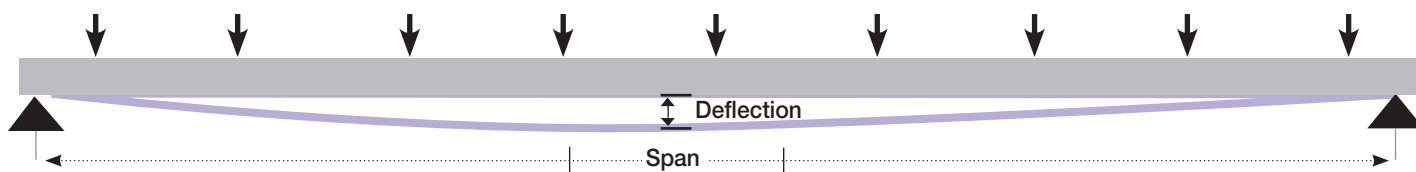
LOAD kg/m (lb./ft.)		SPAN. m (ft.)				
kg/m	(lb./ft.)	1.5 (5)	2.4 (8)	3.0 (10)	3.7 (12)	6.0 (20)
37	(25)	5AA	8AA	10AA	12AA	20AA
74	(50)	5A	8A	10A	12A	20A
112	(75)		8B		12B	20B
149	(100)		8C		12C	20C

Note: These ratings are also used in Mexico

**Table 2**

Span/Load Class Designation — CANADA

LOAD kg/m (lb./ft.)		SPAN. m (ft.)							
kg/m	(lb./ft.)	1.5 (5)	2.0 (6.5)	2.5 (8.2)	3.0 (10)	4.0 (13)	5.0 (16.4)	6.0 (20)	
37	(25)				A				
45	(30)			A					
62	(42)		A						
67	(45)							D	
82	(55)						D		
97	(65)				C				
99	(67)	A							
112	(75)							E	
113	(76)					D			
119	(80)			C					
137	(92)						E		
164	(110)		C						
179	(120)				D				
189	(127)					E			
259	(174)	C							
299	(200)				E				



## 2. Select the Tray Class / Load Capacity (Loading) (cont'd)

### Selection Process

**Cable Loads:** ..... The cable load is the total weight, expressed in (kg/m), of all the cables that will be placed in the cable tray.

**Snow Loads:** ..... The additional design load from snowfall should be determined using the building codes which apply for each installation.

**Ice Loads:**..... The additional load design due to the ice is determined by the following formula:

$$W_i = W \times T_i \times D_i / 144$$

Where:

$W_i$  = ice load (lb./ft.)

$W$  = width of the tray (inches)

$T_i$  = maximum ice thickness (inches)

$D_i$  = 57 lb./ft.<sup>3</sup> - ice density

$$W_i = W \times T_i \times D_i / 10^6$$

Where:

$W_i$  = ice load (kg/m)

$W$  = width of the tray (mm)

$T_i$  = maximum ice thickness (mm)

$D_i$  = 913 kg /m<sup>3</sup> - ice density

Ice thickness will vary depending on installation location. A value of 1/2 inch can be used as a conservative standard for Canada.

**Wind Loads:** ..... The additional loading to be considered is the effect of the impact pressure normal to the side rail. This loading is determined by the following formula:

$$W_p = 0.00256 \times V^2 \times H / 12$$

Where:

$W_p$  = loading due to the wind (lb.)

$V$  = wind velocity (mph)

$H$  = Height of the side rail (inches)

**It is important to note that cable tray is not designed to support personnel.**

**The user should display appropriate warnings to prevent the use of cable tray as walkways.**

### Concentrated Loads

A concentrated static load is not included in the Table 1. Some user applications may require that a given concentrated static load be imposed over and above the working load.

Such a concentrated static load represents a static weight applied on the centerline of the tray at midspan. When so specified, the concentrated static load may be converted to an equivalent uniform load ( $W_e$ ) in kilograms/metre (pounds), using the following formula, and added to the static weight of cable in the tray:

$$W_e = \frac{2 \times (\text{concentrated static load, kg (lb.)})}{\text{Span length, m (ft.)}}$$

### Seismic Loads

It is now known that cable tray systems can withstand stronger earthquakes than previously thought. The tray itself and the support material are highly ductile, and the cables moving within the tray tend to dissipate energy. However, if you have specific seismic specifications for selected cable tray, please consult Thomas & Betts to ensure your specifications are met.

## 2. Select the Tray Class / Load Capacity (Loading) (cont'd)

### Loading for Grades B, C and D

#### General Loading Requirements and Maps (IEEE: Section 25 Loading for Grades B, C and D)

##### General

1. It is necessary to estimate the loadings that may be expected to occur on a line because of wind and ice during all seasons of the year. These weather loadings shall be the values of loading resulting from the application of Rules 250B or 250C. Where both rules apply, the required loading shall be the one that, when combined with the appropriate overload capacity factors, has the greater effect on strength requirements.
2. Where construction or maintenance loads exceed those imposed by Rule 250A1, which may occur more frequently in light loading areas, the assumed loadings shall be increased accordingly.
3. It is recognized that loadings actually experienced in certain areas in each of the loading districts may be greater, or in some cases, may be less than those specified in these rules. In the absence of a detailed loading analysis, no reduction in the loadings specified therein shall be made without the approval of the administrative authority.

##### Combined Ice and Wind Loading

Three general Angles of loading due to weather conditions are recognized and are designated as heavy, medium, and light loading.

**Figure 250-1** shows the districts in which these loadings are normally applicable.

**Figure 250-1** shows the radial thickness of ice and the wind pressures to be used in calculating loading. Ice is assumed to weight 57 lb./ft.<sup>3</sup> (913 kg/m<sup>3</sup>).

##### Extreme Wind Loading

If any portion of a structure or its supported facilities exceeds 60 ft. (18m) above ground or water level, the applicable horizontal wind speed of **Figure 250-2**, as determined by the linear interpolation, shall be used to calculate horizontal wind pressures. These pressures shall be applied to the entire structure and supported facilities without ice loading.

The following formulas shall be used to calculate wind pressures on cylindrical surfaces:

$$\text{pressure in lb./ft.}^2 = 0.00256 (v \text{ m/h})^2$$

$$\text{pressure in pascals} = 0.613 (v \text{ m/h})^2$$

where m = mètres

s = seconds

**Figure 250-2** lists the conversions of velocities to pressures for typical wind speeds as calculated by the formulas listed above. If no portion of the structure or its supported facilities exceeds 60 ft. (18m) above ground or water level, the provisions of this rule are not required.

**For Canadian customers**, please refer to Annex A (page A216) for **Figure 250-1CDN** and **Figure 250-2CDN**.

**For American customers**, please refer to Annex B (page A217) for **Figure 250-1USA** and **Figure 250-2USA**.



## 2. Select the Tray Class / Load Capacity (Loading) (cont'd)

### Structural Design

An installed cable tray system functions as a beam under a uniformly distributed load. The four basic beam configurations found in cable installations are simple, continuous, cantilever and fixed. Each is attached to the cable tray support in a different way.

#### Continuous Beam

Cable tray sections forming spans constitute a continuous beam configuration, the most common found in cable tray installations. This configuration exhibits characteristics of the simple beam and the fixed beam. For example, with loads applied to all spans at the same time, the ends spans function like simple beams, while the counterbalancing loads on either side of a support function like a fixed beam. As the number of spans increases, the continuous beam behaves increasingly like a fixed beam, and the maximum deflection continues to decrease. As this occurs, the system's load carrying capability increases.

#### Simple Beam

A straight section of cable tray supported at both ends but not fastened functions as a simple beam. Under a load, the tray will exhibit deflection. The load carrying capacity of a cable tray unit should be based on simple beam loading, since this type of loading occurs at run ends, offsets, etc., in any tray system. The NEMA/CSA Load Test is a simple beam, uniformly distributed load test, used primarily because it is easy to test and represents the worst case beam condition compared to continuous or fixed configurations. The only criterion for NEMA/CSA acceptance is the ability to support 150% of the rated load.

#### Fixed Beam

Like the cantilever beam, a fixed beam applies more to the cable tray supports than the tray itself, because both ends of a fixed beam are firmly attached to the supports. The rigid attachment prevents movement and increases load bearing ability.

#### Cantilever Beam

A cantilever beam has more to do with the cable tray supports than the tray. Attaching one end of a beam to a support while the other end remains unsupported, as when wall mounting a bracket, creates a cantilever beam configuration. Obviously, with one end unsupported, the load rating of a cantilever beam is significantly less than that of a simple beam.

#### Design Loadings

Basic cable trays are designed on the basis of maximum allowable stress for a certain section and material. The allowable cable load varies with the span, type and width of the tray.

## 2. Select the Tray Class / Load Capacity (Loading) (cont'd)

### Structural Design (cont'd)

#### Splicing

Since the need for a continuous system requires that side rails be spliced, splice plates must be both strong and easy to install. Thomas & Betts Aluminum Snap-In Splice Plate allows hands free installation of hardware for easier assembly. If practical, splices in a continuous span cable tray system should be installed at points of minimum stress. Unspliced straight sections should be used on all simple spans and on end spans of continuous span runs. Straight section lengths should be equal to or greater than the span length to ensure not more than one splice between supports.

Examples of splicing configurations are shown on page A27.

#### Basic Design Stresses

Allowable working stresses are the basis for all structural design. Since they must be of such magnitude as to assure the safety of the structure against failure, their selection is a matter of prime importance. In practice, a basic design stress is determined by dividing the strength of the material by a factor of safety. The determining factors in establishing a set of basic design stresses for a structure are therefore the mechanical properties of the materials and suitable factors of safety. Yield strength and ultimate strength are the mechanical properties most commonly considered to govern design. Values for these properties are readily obtainable. In determining the factor of safety, the designer must usually be guided by current practice—the “standard specifications” adopted by various technical societies and associations—and his or her own judgment and experience.

#### Factors of safety

Since a low value for the factor of safety results in economy of material, the designer seeks to establish a value as low as is practical, based on sound engineering judgment and experience. In making the determination, consideration of the following factors are highly important:

***The accuracy with which the loads to represent service conditions are selected and assumed.*** If there is much doubt concerning these loads, the basic design stress will have to be more conservative than under conditions where the loads are known with considerable accuracy.

***The accuracy with which the stresses in the members of a structure are calculated.*** Many approximations are used in structural design to estimate stress distribution. The choice of a factor of safety should be consistent with how accurate the analysis is. The more precise the method, the greater the allowable unit stress may be.

***The significance of the structure being designed.*** The designer must keep in mind the relative importance of the structure and appraise the possibility of its failure causing significant property damage or loss of life. In this respect, the significance of the design will govern the choice of a factor of safety to a considerable extent.

The factors of safety used in designing most common types of structures are an outgrowth of the experience gained from many applications and tests—even failures. The trend in recent years has been to reduce the factors of safety in line with improved quality of material and increasing knowledge of stress distribution. Further reductions may be made in the future as greater accuracy in determinations becomes possible and practicable.

## 2. Select the Tray Class / Load Capacity (Loading) (cont'd)

### Structural Design (cont'd)

#### Application of design stresses to cable tray systems

A cable tray manufacturer must design standard products to accommodate the great variations encountered in applications. The factors affecting the selection of a suitable basic design stress necessarily result in more conservative stresses than might otherwise be required.

An engineer, who is in a position to determine specific stress requirements with a far greater degree of accuracy, may consider that the manufacturer's basic design stresses are too conservative for a particular project. Using individual experience and judgment, he or she would establish a new set of basic design stresses, selecting those safety factors that would result in a cable tray system best suited to meet the projected service conditions. With these stresses, the engineer can easily calculate an increase or decrease in the manufacturer's loading data, since the load is always in direct proportion to the stress.

The factors of safety used in determining maximum allowable stresses are as follows:

- **Aluminum Alloys**

- a. For tension: the lower of 1/3 the minimum ultimate strength or 1/2 the minimum yield strength in tension.
- b. For compression: the lower of 1/3 the minimum ultimate strength or 2/5 the minimum yield strength in compression.
- c. For shear: the lower of 1/3 the minimum ultimate strength or 1/2 the minimum yield strength in shear.

- **For Hot Rolled Steels**

- a. For tension: the lower of 1/2 the minimum ultimate strength or the minimum yield point in tension times .61.
- b. For compression: the lower of 1/2 the minimum ultimate strength or the minimum yield point in compression times .61.
- c. For shear: maximum stress not to exceed a value of 2/3 the basic design stress for tension.

#### Design Efficiency

A tray designed to perform its required function with the minimum weight (which facilitates installation) requires the material to be used in the most effective manner. The design requirements of side rails are different from those of rungs or ventilated bottom; fabricated tray allows the designer to use different shapes and thicknesses of metal to the best advantage. The strength of the side rail and rungs is increased by the proper use of metal in the high strength heat-treated aluminum or continuously rolled cold-worked steel sections.

## 2. Select the Tray Class / Load Capacity (Loading) (cont'd)

### Loading

### Load Diagrams for Beams

#### CANTILEVER BEAMS

##### Uniform Load

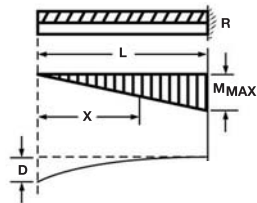
Reaction  $R = wL = W$

Moment at any point:  $M = \frac{wX^2}{2} = \frac{WX^2}{2L}$

Maximum moment  $M_{max} = \frac{wL^2}{2} = \frac{WL}{2}$

Maximum deflection,  $D = \frac{wL^4}{8EI} = \frac{WL^3}{8EI}$

Maximum Shear,  $V = wL$



##### Concentrated Load at Free End

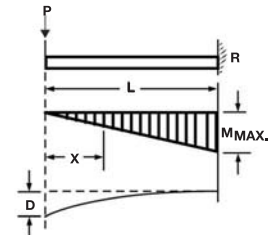
Reaction;  $R = P$

Moment at any point:  $M = Px$

Maximum moment,  $M_{max} = PL$

Maximum deflection,  $D = \frac{PL^3}{3EI}$

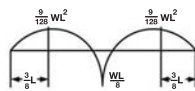
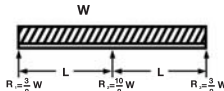
Maximum Shear,  $V = P$



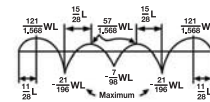
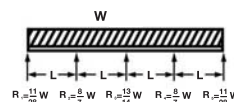
#### CONTINUOUS BEAMS

##### Two Span

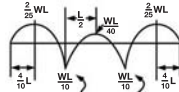
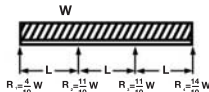
$W = wL$



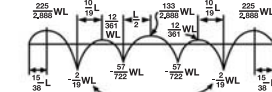
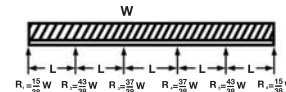
##### Four Span



##### Three Span



##### Five Span



#### SIMPLE BEAMS

##### Uniform Load

w per unit of length, total load  $w$

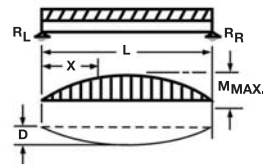
ReactionS:  $R_L = R_R = \frac{wL}{2} = \frac{W}{2}$

Moment at any point:  $M = \frac{wX(L-X)}{2} = \frac{WX(L-X)}{2L}$

Maximum moment, AT CENTER  $M_{max} = \frac{wL^2}{8} = \frac{WL}{8}$

Maximum deflection:  $D = \frac{5wL^4}{384EI} = \frac{5WL^3}{384EI}$

Maximum Shear:  $V = \frac{wL}{2}$



##### Concentrated Load AT CENTER

Reaction  $R_L = R_R = \frac{P}{2}$

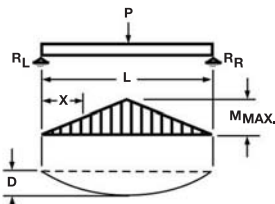
Moment at any point:  $X \leq \frac{L}{2}, M = \frac{PX}{2}$

$X > \frac{L}{2}, M = \frac{P(L-X)}{2}$

Maximum moment, AT CENTER,  $M_{max} = \frac{PL}{4}$

Maximum deflection,  $D = \frac{PL^3}{48EI}$

Maximum Shear,  $V = \frac{P}{2}$



##### Concentrated Load at any Point

Reaction:  $R_L = \frac{Pb}{L}, R_R = \frac{Pa}{L}$

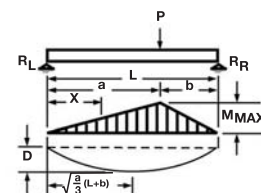
Moment at any point:  $X \leq a, M = R_L X = \frac{PbX}{L}$

$X > a, M = R_R (L-X) = \frac{Pa(L-X)}{L}$

Maximum moment, At  $X = a, M_{max} = \frac{Pab}{L}$

Maximum deflection,  $D = \frac{Pab(L+b)3a(L+b)}{27EIL}$

Maximum Shear,  $V = \frac{Pa}{L}$ , WHEN  $a > b$



### 3. Select the Tray Type

#### Cable tray is available with three styles of bottom:

**Ladder Cable Tray** is a prefabricated structure consisting of two longitudinal side rails connected by individual transverse members.

**Ventilated Cable Tray** is a prefabricated structure consisting of a ventilated bottom within integral or separate longitudinal side rails, with no openings exceeding 4 in. in a longitudinal direction.

**Solid Bottom Cable Tray** is a prefabricated structure without openings in the bottom.

Ladder tray is most often used because of its cost-effectiveness. The designer has a choice of four nominal rung spacings: 6, 9, 12, and 18 inches. The greatest rung spacing compatible with an adequate cable bearing surface area should be selected. Heavy power cables often require greater cable bearing area due to the possibility of creep in the jacket material of the cable. If this is a concern, consult the cable manufacturer. This condition may require the use of ventilated tray, which also offers additional mechanical protection for the cables. Local building codes may require totally enclosed cable tray systems under certain conditions. The designer should verify these before specifying the type of tray to be used.

### 4. Select the Tray Size

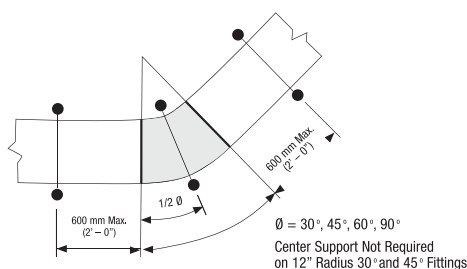
The width or height of a cable tray is a function of the number, size, spacing and weight of the cables in the tray. Available nominal widths are 6, 9, 12, 18, 24, 30, 36 and 42 inches.

When specifying width, it is important to remember that the load rating does not change as the width increases. Even with six times the volume, a 36 in. wide tray cannot hold any more weight than a 6 in. wide tray. If the load rating of the tray permits, cable can be piled deeper in the tray. Most tray classes are available in a nominal 3-5/8, 4, 5, 6 and 7 inches (8 inch height also available as a special - see appendix). Cable ties or other spacing devices may be used to maintain the required air space between cables.

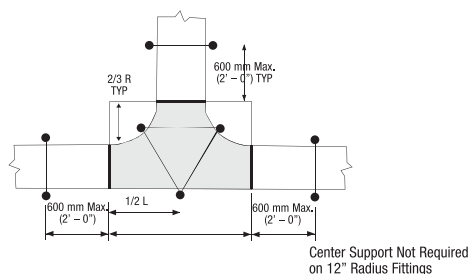
## 5. Select the Fittings

Fittings are used to change the size or direction of the cable tray. The most important decision to be made in fitting design concerns radius. The radius of the bend, whether horizontal or vertical, can be 12, 24, 36 or 48 in., or even greater on a custom basis. The selection requires a compromise with the considerations being available space, minimum bending radius of cables, ease of cable pulling, and cost. The typical radius is 24 in. Fittings are also available for 30°, 45°, 60°, and 90° angles. When a standard angle will not work, field fittings or adjustable elbows can be used. It may be necessary to add supports to the tray at these points. Refer to NEMA VE2 Installation Guidelines for suggested support locations. Note that fittings are not subject to NEMA/CSA load ratings.

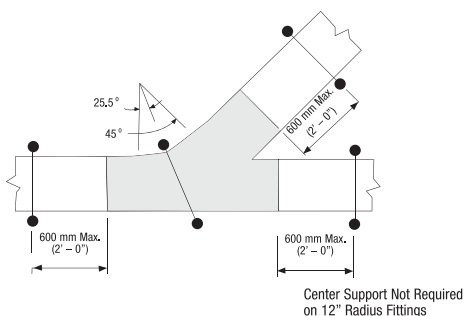
### Support Locations for Fittings



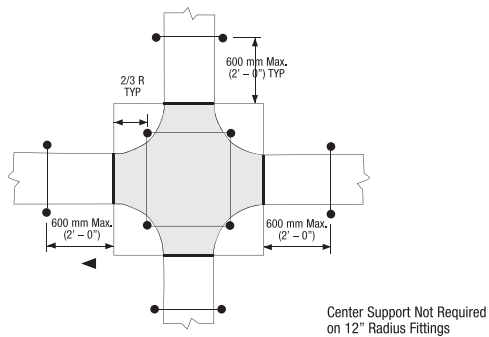
HORIZONTAL ELBOWS



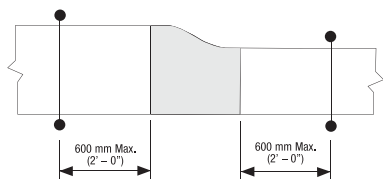
HORIZONTAL TEE



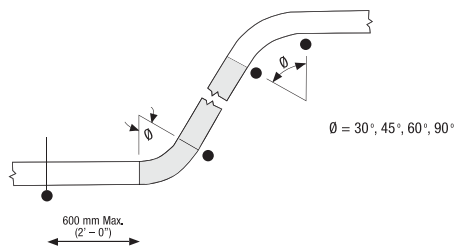
HORIZONTAL WYE



HORIZONTAL CROSS



REDUCER



VERTICAL ELBOWS (side view)

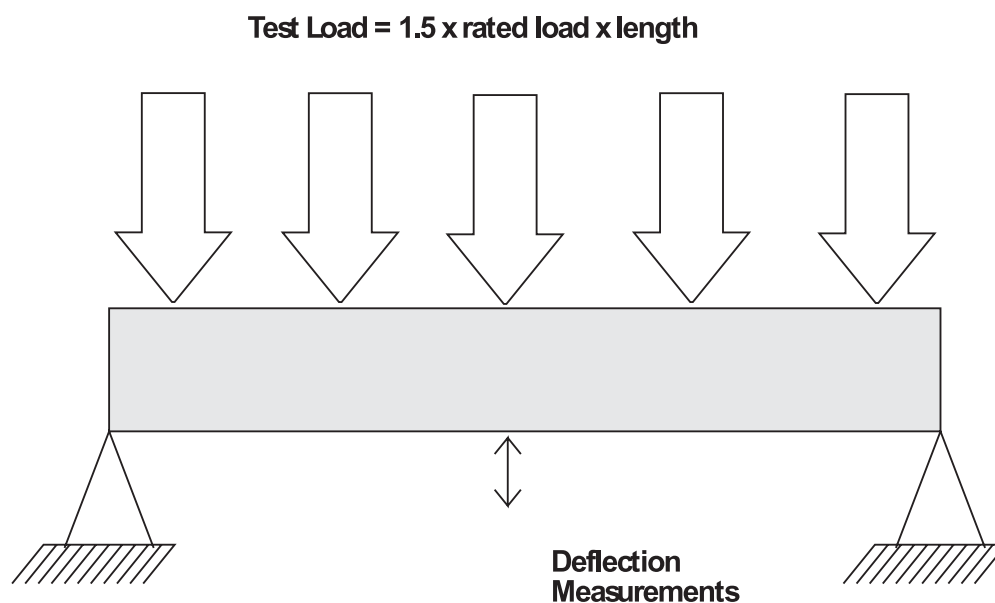
### 6. Consider Deflection

Deflection of the cable tray affects the appearance of an installation, but it is not a structural issue. In the case of nonmetallic cable tray, deflection may be affected by elevated temperatures.

The NEMA/CSA load test is a simple beam, uniformly distributed load test (see Figure 1.2). This type of test was initially selected because:

- It was easiest to test.
- It represents the worst case beam condition compared to continuous or fixed configurations. When consulting the manufacturer's catalogue for deflection information, the designer must verify whether the data shown represents simple or continuous beam deflection. If continuous beam deflection is shown, the calculation factor should be given.

NEMA/CSA has one criterion for acceptance under their load test: the ability to support 150% of the rated load.



**Figure 1.2**



## 6. Consider Deflection (cont'd)

### Simple Versus Continuous Beam Deflection

Theoretical maximum deflection for a simple beam, uniformly distributed load may be calculated as:

$$.0130 \frac{w L^4}{E I} \times 1728 = 22.5 \frac{w L^4}{E I}$$

Where: w = Load in lb./ft.  
 L = Length in ft.  
 E = Modulus of Elasticity lbf/in<sup>2</sup> (psi)  
 I = Moment of Inertia in in<sup>4</sup>

The maximum deflection calculation for a continuous beam of two spans with a uniformly distributed load is:

$$.00541 \frac{w L^4}{E I}$$

A continuous beam of two spans therefore has a theoretical maximum deflection of only 42% of its simple beam deflection. As the number of spans increases, the beam behaves increasingly like a fixed beam, and the maximum deflection continues to decrease. As this occurs, the system's load carrying capability increases.

### Simple vs. Continuous Beam Deflection

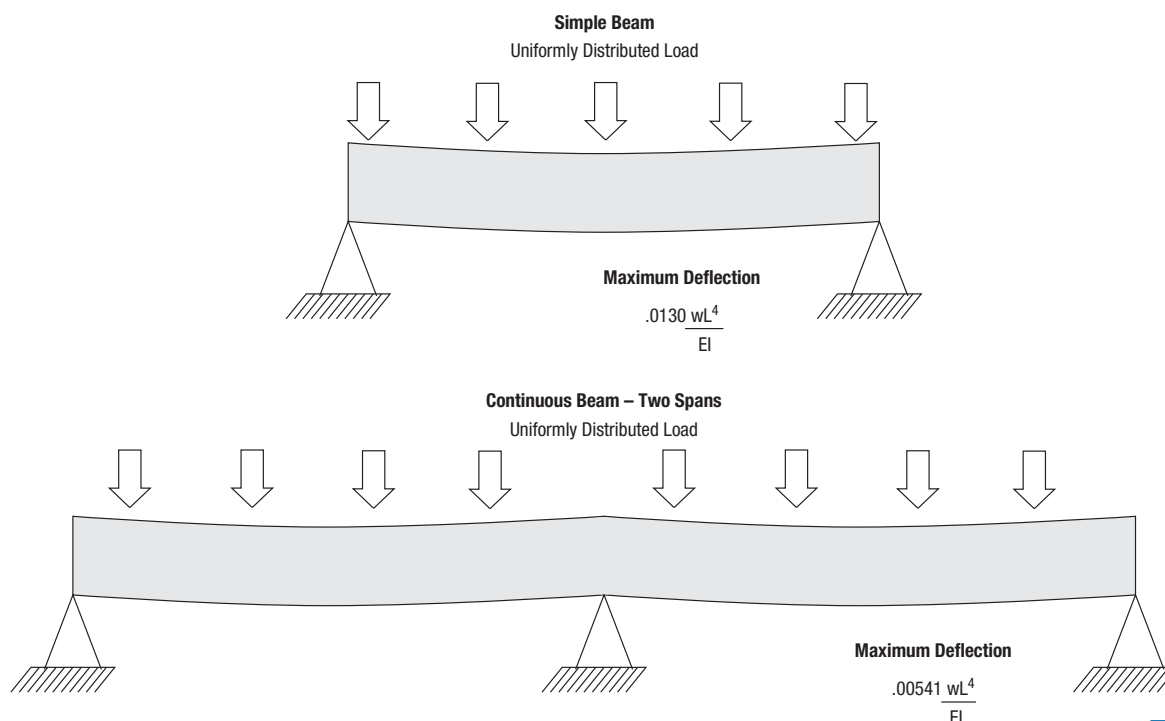
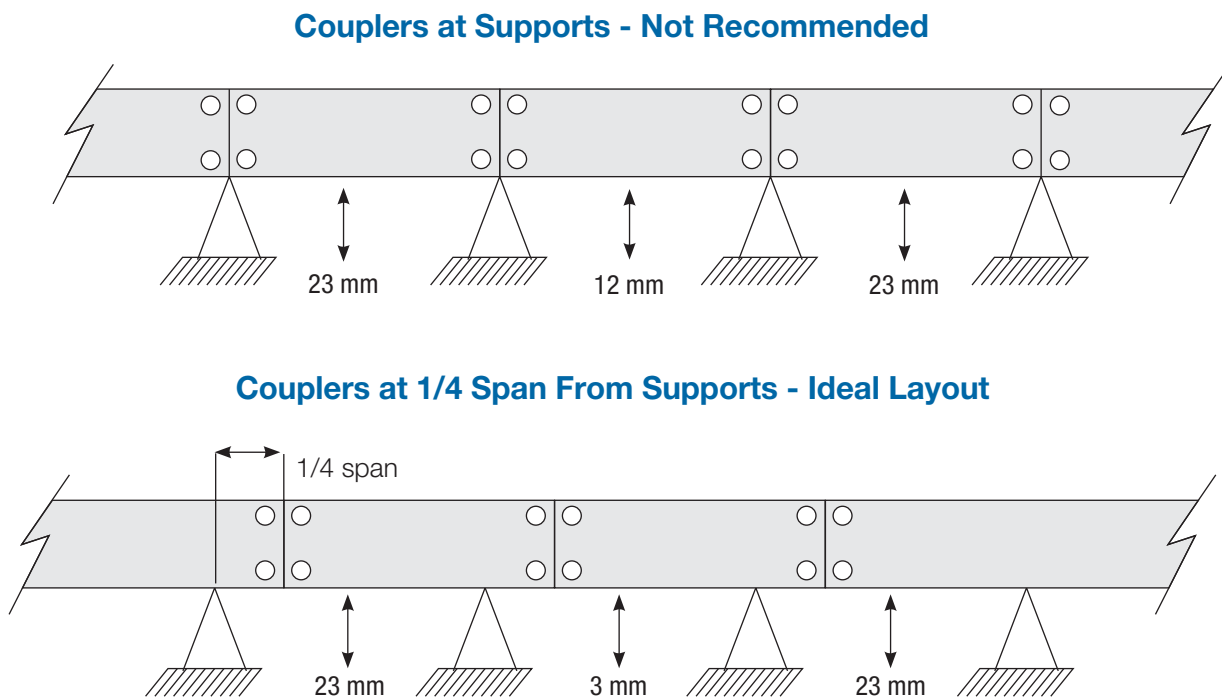


Figure 1.3

### 6. Consider Deflection (cont'd)

#### Location of Couplers

Since different bending moments are created in each span, there is no simple factor to approximate deflection as the number of spans increases. It is possible to calculate these deflections at any given point by using second integration of the basic differential equation for beams. Testing shows that the center span of a three-tray continuous beam can deflect less than 10 % of its simple beam deflection.



**Figure 1.4**

The support span should not be greater than the straight section length, to ensure no more than one splice is located between supports.

#### Location of Couplers

(see Figure 1.4) The location of the coupler dramatically affects the deflection of a cable tray system under equal loading conditions. Testing indicates that the maximum deflection of the center span of a three-span tray run can decrease four times if the couplers are moved to the one-quarter point from the above supports.

This can be a major concern for designers considering modular systems for tray and pipe racks.

7. Consider Thermal Expansion & Contraction

A cable tray system may be affected by thermal expansion and contraction, which must be taken into account during installation. To determine the number of expansion splice plates you need, decide the length of the straight cable tray runs and the total difference between the minimum winter and maximum summer temperatures. To function properly, expansion splice plates require accurate gap settings between trays. To find the gap (see Figure 2):

Plot your gap setting

- a. Locate the lowest metal temperature on low temperature line.
- b. Locate the highest metal temperature on high temperature line.
- c. Connect these two points.
- d. Locate installation temperature and plot to high/low line. Drop plot to gap setting.

Table 1

Maximum distance between expansion joints  
(For 1 in. Movement)

Temperature Differential		316 Stainless Steel		Steel		Aluminum	
°C	°F	m	Feet	m	Feet	m	Feet
14	25	115	379	156	512	79	260
28	50	58	189	78	256	40	130
42	75	38	126	52	171	27	87
56	100	29	95	39	128	20	65
70	125	23	76	31	102	16	52
83	150	19	63	26	85	13	43
97	175	16	54	22	73	11	37

Note: Every pair of expansion splice plates requires two bonding jumpers for grounding continuity.

The support nearest the midpoint between expansion splice plates should be anchored, allowing the tray longitudinal movement in both directions. All other support location should be secured by expansion guides. (See Figure 3)

Figure 2

Gap Setting of Expansion Splice Plate

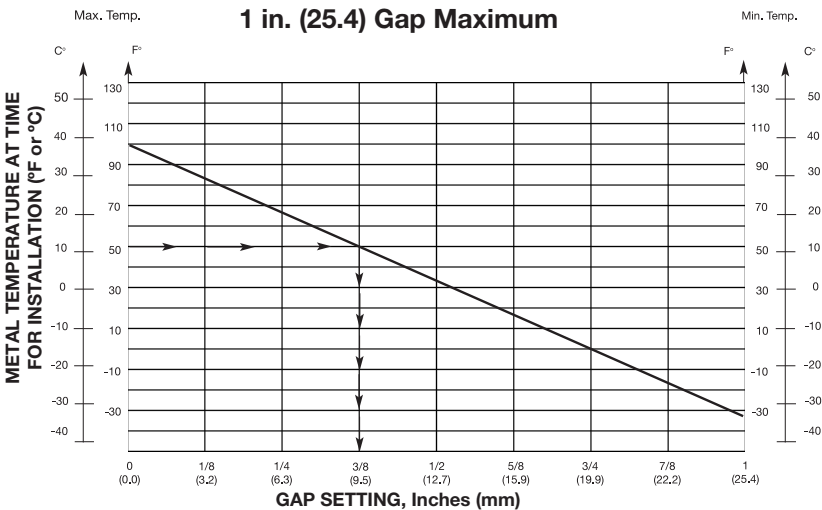
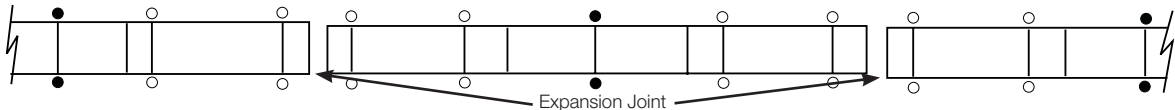


Figure 3

Typical Cable Tray Installation



● = hold down clamp (anchor) at support  
○ = expansion guide clamp at support

## 8. Electrical Grounding Capacity

The National Electrical Code, Article 392-7 allows cable tray to be used as an equipment grounding conductor. All Thomas & Betts standard cable trays are classified by Underwriter's Laboratories per US NEC Table 392-7 based on their cross sectional area.

The corresponding cross-sectional area for each side rail design (2-side rails) is listed on the label. This cable tray label is attached to each straight section that is UL classified. Fittings are not subject to CSA or UL.

### NEC TABLE 392.7 (B)

Metal Area Requirements for Cable Trays

Used as Equipment Grounding Conductors

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

**For SI units:** 1 in<sup>2</sup> = 645 mm<sup>2</sup>.

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

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

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

See pages A221 to A223 for grounding and bonding products.

For more information on grounding and bonding cable tray refer to section 4.7 of the NEMA VE 2-2006 Cable Tray installation guidelines.

## Engineering Cable Tray Specification

### Cable Tray

- Cable tray shall be by one manufacturer and shall consist of straight sections, fittings and accessories per NEMA VE1-2006/CSA C22.2 No. 126.1-02. Cable Tray must be listed by UL as equipment grounding conductor. There shall be no burrs, projections or sharp edges to damage the cable insulation.

### Material

- Aluminum - All side rails, and rungs shall be of extruded aluminum type 6063-T6. Side rails shall be of I-beam construction.
- Pregalvanized steel - All side rails and rungs shall be of steel conforming to the requirements of ASTM A653/A653M-06a with G90 coating thickness. Side rail shall be reinforced with flanges turned inward.
- Hot-dipped galvanized Steel - All side rails and rungs shall be made from steel conforming to the requirements of A1008/A1008M-07,SS grade 33, type 2 or A1011/A1011-06b SS, grade 33 and shall be Hot-dipped galvanized after manufacture per ASTM A123 providing a minimum thickness of 1.50 oz per ft.<sup>2</sup>
- Stainless Steel - All cable tray and accessories shall be of type AISI 316 stainless steel.

### Tray Types

- Ladder - Ladder tray shall incorporate two side rails connected by lateral rungs. Rungs shall provide minimum 1 in. bearing surface and have slots perpendicular to the centerline of the rung on 1 in. centers for attachment of cable ties. Rungs shall also have an open slot to facilitate attachment of pipe straps and other accessories. Rungs shall be installed at 6, 9, 12 or 18 in. spacing. The rungs shall not be below the bottom of the side rail.
- Solid Bottom - Solid Bottom tray shall incorporate two side rails connected by rungs on 12 in. centers with a solid sheet applied below the rungs.
- Ventilated Trough - Ventilated trough tray shall incorporate two side rails connected by rungs at 4 in. spacing.

### Dimensions

- Side rail height - Side rails heights shall be 3-5/8, 4, 5, 6 and 7 in. minimum loading depths shall be 2-5/8, 3, 4, 5, and 6 in.
- Length - All cable tray straight sections shall be supplied in 12 ft., 24ft., 3m and 6m lengths.
- Width - Cable tray shall be supplied in 6, 9, 12, 18, 24, 30 and 36 in. widths as required.
- Radius Fittings - For all fittings requiring a radius that radius shall be 12, 24, 36 or 48 in. and shall be measured to the nearest perpendicular surface.

### Accessories

- Covers and Accessories - Covers shall be supplied to protect tray cable where needed. Appropriate holddowns shall be supplied to properly attach the covers to the tray.
- Splice Plates - Aluminum splice plates shall be designed to snap into tray side rail and shall be supplied with four square neck carriage bolts and hex nuts for attachment. Steel splice plates shall be supplied with four square neck carriage bolts and hex nuts for attachment.

### Loading Capabilities

- Cable tray shall meet specified NEMA/CSA load ratings with safety factor of 1.5. The cable tray should also be able to support a 200 lb. concentrated load at midspan over and above stated cable load.

### Design and Manufacture

- Cable tray design shall be that of T&B Cable Tray Systems as manufactured by Thomas & Betts.

## Engineering Cable Tray Specification (cont'd)

### Selection of Thomas & Betts Series of Cable Tray

— Please refer to Table 2 for Aluminum and Table 3 for Steel — (page A32)

**Table 1a**

Span/Load Class Designation — USA  
(See Clauses 4.8.1, 4.8.2 and 6.1.2 (c).)

LOAD kg/m (lb./ft.)		SPAN, m (ft.)				
kg/m	(lb./ft.)	1.5 (5)	2.4 (8)	3.0 (10)	3.7 (12)	6.0 (20)
37	(25)	5AA	8AA	10AA	12AA	20AA
74	(50)	5A	8A	10A	12A	20A
112	(75)		8B		12B	20B
149	(100)		8C		12C	20C

Note: These ratings are also used in Mexico.

**Table 1b**

Span/Load Class Designation — CANADA  
(See Clauses 4.8.1, 4.8.2 and 6.1.2 (c).)

LOAD kg/m (lb./ft.)		SPAN, m (ft.)						
kg/m	(lb./ft.)	1.5 (5)	2.0	2.5	3.0 (10)	4.0	5.0	6.0 (20)
37	(25)				A			
45	(30)			A				
62	(42)		A					
67	(45)							D
82	(55)						D	
97	(65)				C			
99	(67)	A						
112	(75)							E
113	(76)					D		
119	(80)			C				
137	(92)						E	
164	(110)		C					
179	(120)				D			
189	(127)					E		
259	(174)	C						
299	(200)				E			

### Engineering Cable Tray Specification (cont'd)

**Table 2**

Aluminum Load / Span Class Designation

Side Rail Height (in.)	Series	Load Depth (in.) Nominal	NEMA Class	CSA Class
<b>4</b>	AH14 AH34 AH54	<b>3</b>	12A 12C 20B	C/3m D/6m E/6m
<b>5</b>	AH25 AH45	<b>4</b>	12C 20B	D/6m E/6m
<b>6</b>	AH16 AH36 AH46 AH56 AH66 AH76	<b>5</b>	12C 20B 20C 20C 20C —	D/6m E/6m — — — —
<b>7</b>	AH37 AH47	<b>6</b>	20C 20C	— —
<b>8</b>	AH18	<b>7</b>	—	—



### Engineering Cable Tray Specification (cont'd)

**Table 3**

Steel Load / Span Class Designation

Side Rail Height (in.)	Series	Load Depth (in.) Nominal	NEMA Class	CSA Class
<b>3-5/8</b>	SH13/SP13/SS13	<b>2-5/8</b>	12A	C/3m
<b>4</b>	SH14/SP14/SS14 SH34/SP34/SS34	<b>3</b>	12C 20A	D/3m D/6m
<b>5</b>	SH25/SP25/SS25 SH45/SP45/SS45 SH55/SP55	<b>4</b>	20A 20B 20C	D/6m E/6m
<b>6</b>	SH16/SP16/SS16 SH36/SP36/SS36 SH46/SP46/SS46	<b>5</b>	20A 20B 20C	D/6m E/6m —
<b>7</b>	SH37/SP37/SS37	<b>6</b>	20C	—