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GENERAL TECHNICAL DATA

This compilation of Technical information is intended to supply essential details relating to Vantrunk's Cable Management Systems. Its aim is to ensure that the specified Cable Management installation is adequately protected against corrosion and has suitable strength & rigidity to provide reliable support at minimum installed cost.

Our Design Team is available to answer any questions relating to particular site requirements which may not be answered in the following sections.

Contents

1. EXTREME ENVIRONMENTS

1.1 Low Temperature Applications

Consideration should be given to the likely affects of low temperatures when specifying cable management products for installation at a location subject to sub zero temperatures.

Manufactured using generic low carbon steels and austenitic stainless steels – general guidance on the low temperature performance of these materials is as follows:

Low Carbon Steels

Low carbon steels used in the manufacture of commercially available cable management systems exhibit a ductile to brittle transition at low temperatures. At these low temperatures an impact can cause cracking which will propagate faster than the elastic deformation, resulting in failure of the product by brittle fracture. Brittle fracture can be avoided by specifying structural grade steels that have certified minimum impact values. These structural steel grades are typically certified at temperatures of 0°C, -20°C, and -40°C, showing a decreasing impact value as the temperature decreases. Vantrunk has manufactured the Speedway cable ladder system for low temperature applications using structural steels of 2.0mm and 2.5mm thickness. These steels have been independently tested at temperatures of -46°C giving average charpy values of 20 joules for 2.0mm thickness.

Austenitic Stainless Steels

Austenitic stainless steels, including grade 1:4404 to BS EN 10088-2 (marine grade 316) which is used in the manufacture of Vantrunk Cable Management systems and accessories, are not affected by sub zero temperatures. These stainless steels do not suffer a loss in either ductility or toughness and are not susceptible to failure by brittle fracture at low temperatures below -20°C. Please contract our Design Team for further information relating to low temperature applications.

1.2 Expansion & Contraction

It is important that thermal expansion and contraction are considered when designing and installing a cable ladder installation. Even in relatively moderate climates there will be sufficient seasonal thermal movement which could easily place undue stresses on the cable ladder installation and the supporting structure.

To incorporate thermal movement in the design of a cable ladder installation it is important to establish the maximum temperature differential which is likely to be encountered at the site of the installation. The temperature differential is based on the maximum and minimum seasonal temperatures. This temperature differential will determine the maximum spacing between expansion couplers within the cable ladder installation.

To facilitate correct installation of the expansion couplers it will be necessary to measure the temperature of the cable ladder at the time of installation and to use this temperature to determine the required 'setting gap' between the adjoining lengths of cable ladder and tray. This will ensure that the movement provided by the expansion coupler is not compromised by incorrect assembly at the time of installation.

1.2.1 Speedway Cable Ladder

The Speedway expansion coupler is designed to allow movement up to a maximum of 28mm. This movement allowance is the basis for determining both the maximum allowable spacing between expansion couplers and the required setting gap at the time of installation.

The maximum allowable spacing between expansion couplers is given in the adjacent table for both hot dip galvanized and stainless steel Speedway Cable Ladder. Intermediate values can be obtained using the formula given under the table.

Maximum Allowable Spacing – Speedway Expansion Couplers

Temperature Differential At Location of Installation		Maximum Spacing Between Expansion Couplers			
		Hot Dip Galvanized		Stainless Steel	
°C	°F	m	ft	m	ft
10	50	229.5	629.6	175.0	480.1
20	68	114.8	314.8	87.5	240.0
30	86	76.5	209.9	58.3	160.0
40	104	57.4	157.4	43.8	120.0
50	122	45.9	125.9	35.0	96.0
60	140	38.3	104.9	29.2	80.0
70	158	32.8	89.9	25.0	68.6
80	176	28.7	78.7	21.9	60.0
90	194	25.5	70.0	19.4	53.3
100	212	23.0	63.0	17.5	48.0

Joints can also be calculated from the following formula: **L = C/T**

Where L = maximum allowable spacing between expansion couplers.

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C = 1147 for low carbon steel cable tray & 875 for stainless steel cable tray

T = temperature differential at installation site.

As an example:
Maximum temperature = +35°C
Minimum temperature = -15°C
Temperature differential = 50°C

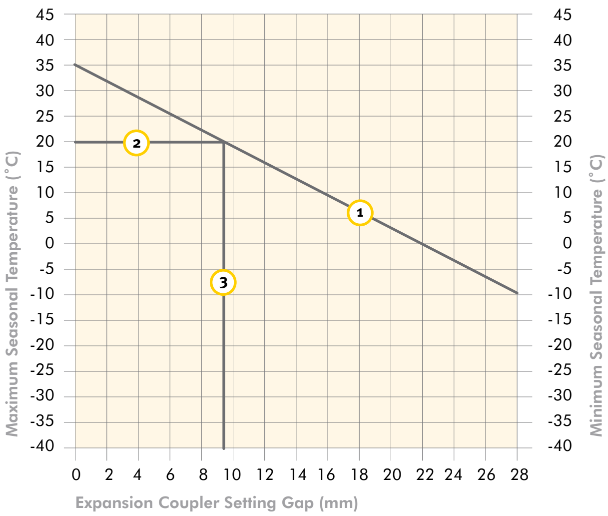
For a temperature differential of 50°C, based on a hot dip galvanized cable ladder system, expansion couplers should be fitted every 46m. For ease of installation, expansion couplers should be fitted at every 15th 3m cable ladder, giving 45m between expansion couplers.

To determine the setting gap at the time of installation the following chart should be used.

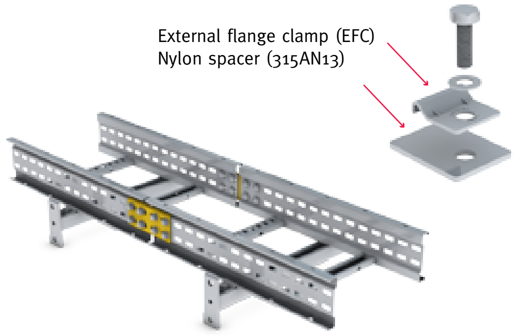
A diagonal line (1) should be constructed between the two vertical axes using the maximum and minimum seasonal temperatures, for example, +35°C & -10°C.

A horizontal line (2) should be constructed for the temperature of the Speedway Cable Ladder at the time of installation, for example +20°C.

A vertical line (3) should be constructed from the intersection of the diagonal and horizontal lines to give the required setting gap, for this example the expansion couplers should be set with a gap of 9.4mm. To ensure safe and correct installation, the Speedway Cable Ladder should be supported within 600mm on each side of connections fitted with expansion couplers. The Speedway expansion couplers should be correctly assembled – refer to 1.2 for further details.



Where installed with expansion couplers, the Speedway Cable Ladder should be secured to the supporting structure using the Speedway external flange clamp (EFC) The Speedway external flange clamp should be installed with nylon spacer pads (part number 315AN13) which will allow the Speedway Cable Ladder to expand and contract in a restrained manner.

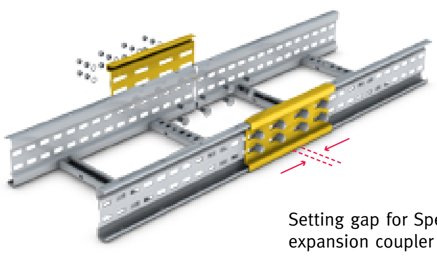


For those installations where is it is not practical to fit supports within 600mm on each side of the expansion joint, or for those installations where there is a requirement to provide an expansion coupler capable of accommodating more than 28mm of movement, consideration should be given to the use of the Speedway Full Moment Expansion couplers.

The Speedway full moment expansion coupler is capable of carrying the full load of the Speedway cable ladder at the expansion joint without the need to provide local support. Typical examples of this type of installation requirement include pipe racks with expansion joints at 50m intervals.

The Speedway full moment expansion coupler provides for a maximum designed movement of 75mm without the need for local support at the location of the expansion joint. The Speedway full moment expansion coupler can accommodate movement in excess of 75mm; however, local support will be required at the location of the expansion joint.

Consult our Technical Team for full details on the installation requirements for the Speedway full moment expansion coupler (including detailed assembly requirements and gap setting at the time of installation).



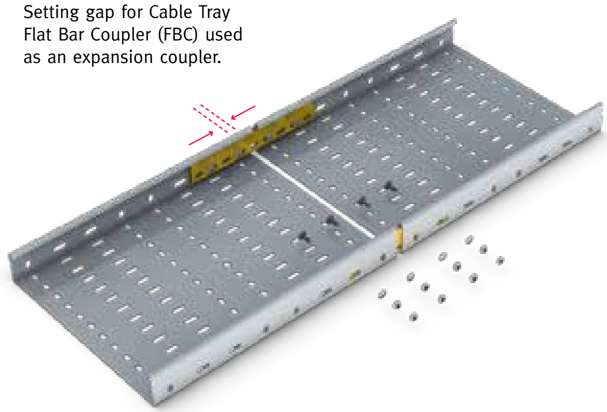
Setting gap for Speedway full moment expansion coupler (CS/EXP).
Supports are not required at the location of the expansion joint.

› 1.2.2 Vantrunk Cable Tray

The standard flat bar coupler can allow movement up to a maximum of 14mm. This movement allowance is the basis for determining both the maximum allowable spacing between expansion joints and the required setting gap at the time of installation.

The maximum allowable spacing between expansion joints is given in the following table for both galvanized (pre-, hot dip & deep) and stainless steel Vantrunk Cable Tray. Intermediate values can be obtained using the formula given under the table.

Setting gap for Cable Tray Flat Bar Coupler (FBC) used as an expansion coupler.



Maximum Allowable Spacing – Cable Tray Expansion Joints

Temperature Differential		Maximum Spacing Between Expansion Joints			
		Hot Dip Galvanized		Stainless Steel	
°C	°F	m	ft	m	ft
10	50	114.8	314.8	87.5	240.0
20	68	57.4	157.4	43.8	120.0
30	86	38.3	104.9	29.2	80.0
40	104	28.7	78.7	21.9	60.0
50	122	23.0	63.0	17.5	48.0
60	140	19.1	52.5	14.6	40.0
70	158	16.4	45.0	12.5	34.3
80	176	14.3	39.3	10.9	30.0
90	194	12.8	35.0	9.7	26.7
100	212	11.5	31.5	8.8	24.0

The maximum allowable spacing between expansion joints can also be calculated from the following formula:

L = C/T

Where L = maximum allowable spacing between expansion couplers.
C = 1147 for low carbon steel cable tray & 875 for stainless steel cable tray.
T = temperature differential at installation site.

As an example:

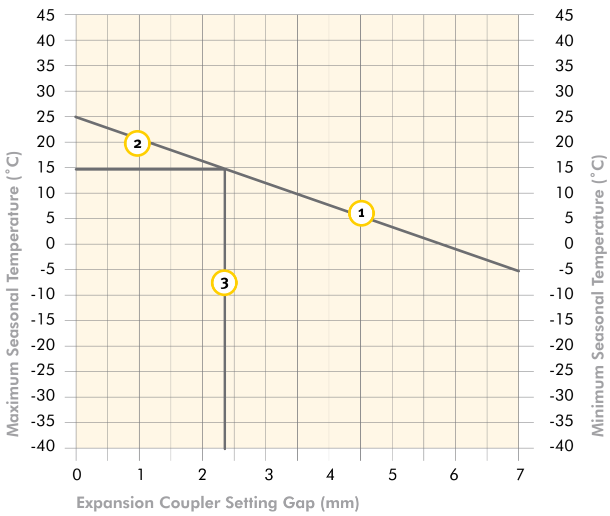
Maximum temperature +25°C

Minimum temperature -5°C

Temperature differential 30°C

For a temperature differential of 30°C, based on a hot dip galvanized cable tray system, expansion joints should be located every 19.1m. For ease of installation, expansion joints should be located at every 6th 3m cable tray, giving 18m between expansion joints.

To determine the setting gap at the time of installation the following chart should be used.



A diagonal line (1) should be constructed between the two vertical axes using the maximum and minimum seasonal temperatures, for example, +25°C & -5°C.

A horizontal line (2) should be constructed for the temperature of the Vantrunk cable tray at the time of installation, for example +15°C.

A vertical line (3) should be constructed from the intersection of the diagonal and horizontal lines to give the required setting gap, for this example the expansion couplers should be set with a gap of 2.3mm.

To ensure safe and correct installation, the Vantrunk Cable Tray should be supported within 300mm on each side of connections fitted with expansion couplers.

The flat bar couplers at each expansion joint should be correctly assembled – refer to 1.2 for further details. Where installed with expansion couplers, the Vantrunk Cable Tray should be secured to the supporting structure in a manner which will allow free movement.

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› 1.3 Bimetallic Corrosion

Bimetallic corrosion (also referred to as galvanic or electrolytic corrosion) occurs when two dissimilar metals are in close contact with an electrolyte. An electrolyte is a medium which allows the flow of an electrical current. The presence of water as moisture can act as an electrolyte. For further details see pages 80 for Speedway Insulation Assemblies and pages 138 for Cable Tray installation assemblies.

The rate of corrosion depends upon the differences in electrical potential of the metals as defined by the Galvanic Series (see chart below), the strength of the electrolyte, the period for which the electrolyte is present, and the geometry of the connection between the dissimilar metals. When corrosion occurs it is the anodic metal (which is higher in the galvanic series) that will corrode in preference to the cathodic metal (which is lower in the galvanic series).

If corrosion takes place between two dissimilar metals, the metal which is higher in the galvanic series will corrode in preference to the metal which is lower in the galvanic series.

Galvanic Series Chart

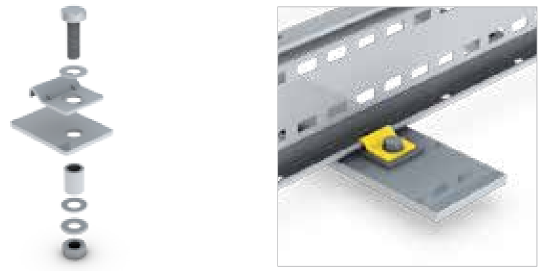
It is common to find dissimilar metals such as stainless steel and mild steel or zinc (as found on a hot dip galvanized item) in contact in a damp atmosphere (i.e. sea water, rain, etc.).

This arrangement is typically found in coastal and offshore applications where painted structures or heavyweight galvanized steel brackets are used to support stainless steel cable ladders on the exterior of an installation.

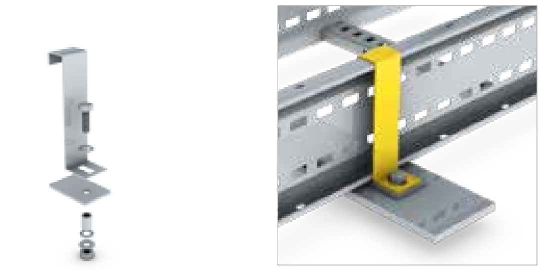
Whilst it is possible to use a layer of paint or grease to separate the stainless steel cable ladder from a zinc coating or any exposed mild steel arising from drilling of the support structure, these should not be considered as a long term means of providing electrical separation between the dissimilar metals.

The best solution is to electrically isolate the two dissimilar metals. Vantrunk cable management systems include a range of nylon pads, bushes, and washers which entirely separates the cable ladder or tray and the fixings from the support structure to prevent bimetallic corrosion.

In a typical insulating assembly the ladder or tray securing device (external flange clamp, hold down bracket, or adaptable fixing bracket), securing bolt, nut, & washer are entirely of stainless steel and are therefore compatible with the stainless steel cable ladder.

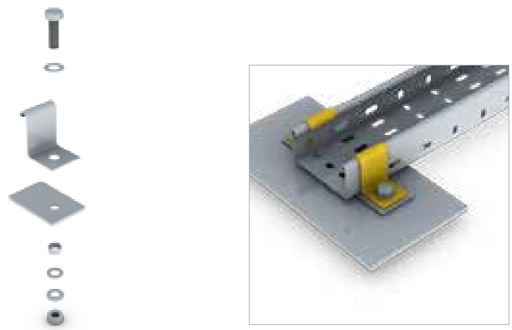


Insulating assembly for External Flange Clamp (EFC)



Insulating assembly for Hold Down Bracket (HDB)

Insulating assembly for Adaptable Fixing Bracket (AFB)



Insulating assembly for Hold Down Bracket (HDB)

1.4 Imposed Loads

Imposed loads include wind, ice and snow. The effects of imposed loads will vary from one installation to another and further advice relating to the specific influences of each should be sought at the design stage. The following information on imposed loads is given as a general guide only.

1.4.1 Ice Loads

When determining the total load to be supported by the Speedway Cable Ladder or Vantrunk Cable Tray an allowance should be made for those locations where ice formation is likely.

The tables below shows the additional load imposed by a layer of ice 10mm thick and having a density of 916kg/m^3.

Ice Load (10mm thick) on Speedway Cable Ladder

Width W mm	Ice Load kg/m		
	Speedway SW4	Speedway SW5	Speedway SW6
150	1.72	1.83	1.83
300	3.10	3.21	3.21
450	4.47	4.58	4.58
600	5.84	5.95	5.95
750	7.22	7.33	7.33
900	8.59	8.70	8.70
1050	9.97	10.08	10.08

Ice Load (10mm thick) on Vantrunk Cable Tray

Tray Width	Ice Load kg/m	
	Medium Duty	Heavy Duty
50	0.46	0.46
75	0.69	0.69
100	0.92	0.92
150	1.37	1.37
200	1.83	1.83
225	2.06	2.06
300	2.75	2.75
450	4.12	4.12
600	5.50	5.50
750	6.87	6.87
900	8.24	8.24

1.4.2 Snow Loads

The magnitude of the additional load imposed by snow will be influenced by a number of factors including the density of the snow, the degree of drifting which will alter the profile of the snow accumulating on the Speedway Cable Ladder or Vantrunk Cable Tray, and the nature of the cable ladder installation (i.e. covers fitted or percentage of cable loading area occupied by cables). The density of snow can vary from 160kg/m3 to 481kg/m3 depending on the level of wetness and compactness. The tables below assume that the snow has a density of 160kg/m3 and is applied to a uniform height of 100mm.

Snow Load (100mm thick) on Speedway Cable Ladder

Width W mm	Snow Load kg/m		
	Speedway SW4	Speedway SW5	Speedway SW6
150	3.01	3.20	3.20
300	5.41	5.60	5.60
450	7.81	8.00	8.00
600	10.21	10.40	10.40
750	12.61	12.80	12.80
900	15.01	15.20	15.20
1050	17.41	17.60	17.60

Snow Load (100mm thick) on Vantrunk Cable Tray

Tray Width	Snow Load kg/m	
	Medium Duty	Heavy Duty
50	0.80	0.80
75	1.20	1.20
100	1.60	1.60
150	2.40	2.40
200	3.20	3.20
225	3.60	3.60
300	4.80	4.80
450	7.20	7.20
600	9.60	9.60
750	12.00	12.00
900	14.40	14.40

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› 1.4.3 Wind Loads

Wind loads exert a sideways force on the cable ladder or cable tray. The sideways force is based on the wind speed and is derived from the equation Vp (N/m^2) = 0.6V^2 where V is the wind speed in m/s. The wind speed will vary relative to the height above the ground and the degree of exposure. The following tables give an indication for the sideways force which will be exerted on Speedway Cable Ladder or Vantrunk Cable Tray in an exposed location at an ambient temperature of 20°C and average relative humidity for the United Kingdom.

The tabulated wind loads are based on Speedway Cable Ladder and Vantrunk Cable Tray that is installed in the horizontal plane. In this orientation the structural properties of the Vantrunk Cable Management Systems are sufficient to resist most normal wind loads. The wind loadings will be significantly higher for edge-mounted Speedway Cable Ladder and Vantrunk Cable Tray and for this reason edge-mounted ladder or tray should not be installed in areas of high wind exposure.

If covers are to be fitted to Speedway Cable Ladder or Vantrunk Cable Tray in locations subject to high wind loads further advice should be sought from our Design Team regarding additional securing means.

Wind Loads on Speedway Cable Ladder

Beaufort Scale	Description	Wind Speed m/s		Pressure N/m²		Wind Loads - kg/m					
						Speedway SW4		Speedway SW5		Speedway SW6	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
0	Calm	0.00	0.20	0.00	0.02	0.00	0.00	0.00	0.0	0.00	0.00
1	Light air	0.30	1.50	0.05	1.35	0.00	0.01	0.00	0.02	0.00	0.02
2	Light breeze	1.60	3.30	1.54	6.53	0.01	0.06	0.02	0.07	0.02	0.09
3	Gentle breeze	3.40	5.40	6.94	17.50	0.06	0.16	0.08	0.20	0.10	0.24
4	Moderate breeze	5.50	7.90	18.15	37.45	0.16	0.34	0.20	0.42	0.25	0.52
5	Fresh breeze	8.00	10.70	38.40	68.69	0.35	0.62	0.43	0.77	0.53	0.95
6	Strong breeze	10.80	13.80	69.98	114.26	0.64	1.04	0.79	1.29	0.97	1.58
7	Near gale	13.90	17.10	115.93	175.45	1.05	1.59	1.31	1.98	1.60	2.43
8	Gale	17.20	20.70	177.50	257.09	1.61	2.34	2.00	2.90	2.45	3.56

Wind Loads on Vantrunk Cable Tray

Beaufort Scale	Description	Wind Speed m/s		Pressure N/m²		Medium Duty 25mm Height		Heavy Duty 50mm Height	
		Min	Max	Min	Max	Min	Max	Min	Max
0	Calm	0.00	0.20	0.00	0.02	0	0	0	0
1	Light air	0.30	1.50	0.05	1.35	0	0.1	0	0.5
2	Light breeze	1.60	3.30	1.54	6.53	0.2	0.7	0.5	2.3
3	Gentle breeze	3.40	5.40	6.94	17.50	0.7	1.8	2.4	6.1
4	Moderate breeze	5.50	7.90	18.15	37.45	1.9	3.9	6.3	13.1
5	Fresh breeze	8.00	10.70	38.40	68.69	4	7.2	13.4	24
6	Strong breeze	10.80	13.80	69.98	114.26	7.3	11.9	24.5	39.9
7	Near gale	13.90	17.10	115.93	175.45	12.1	18.3	40.5	61.3
8	Gale	17.20	20.70	177.50	257.09	18.5	26.8	62	89.8

2. Materials & Finishes

Details relating to the standard materials and finishes for Vantrunk Cable Management Systems, components, and accessories are given in the following sections. The choice of material and finish has been based on many years experience in providing cable management products and support systems for use in industrial and onshore/offshore installations.

2.1 Materials

The following materials are used in the manufacture of the Vantrunk Cable Management Systems, components and accessories:

Mild steel
Hot Rolled Mild steel grade D11 to BS EN 10111
Cold Rolled Mild steel grade Ds01 to BS EN 10130
Structural steel grade S275 to BS EN 10025-2

Stainless steel
Marine grade stainless steel 1.4404
to BS EN 10088-2

Silicon-rich steel
S355JoWP grade steel to BS EN 10025-5
S355J2W grade steel to BS EN 10025-5

Hot dip galvanized
(before manufacture)
Grade S250+Z275 to
BS EN 10326 steel

2.1.1 Mild Steel

Vantrunk Cable Management Systems, components and accessories are manufactured using three different types of mild steel, each of which is matched for performance and strength to the product and the intended application. These mild steel materials are hot-rolled steel, cold-rolled steel and structural steel grade. Mild steel products require subsequent finishing on completion of manufacture to provide a means of corrosion protection.

Mechanical Properties of Mild Steel

Material Grade	Property		
	Yield Strength ReH N/mm²	Tensile Strength Rm N/mm²	Elongated A %
DD11	170 to 360	440	23
DC01	280 Max	270 to 410	28
S275	275 Min	430 to 580	14

Hot-rolled Mild Steel Grade DD11 to BS EN 10111
(formerly HR4 to BS 1449 Part 1)

DD11 hot-rolled mild steel is a cold forming material used for bending and drawing applications. This material is suitable for welding and hot dip galvanizing

Cold-rolled Mild Steel Grade DC01 to BS EN 10130

(formerly CR4 to BS 1449 Part 1)

DC01 cold-rolled steel grade is a cold-forming material for forming and deep drawing applications. This material is suitable for welding and hot dip galvanizing.

Structural Steel Grade S275 to BS EN 10025-2

(formerly 43A to BS 1449 Part 1)

S275 steel is a weldable, high-strength structural steel with good galvanizing properties.

2.1.2 Stainless Steel

The Speedway Cable Ladder System, components and accessories are manufactured using 1.4404 marine grade stainless steel (316) which is matched for performance and strength to the product and the intended application.

The corrosion resistance of stainless steel arises from a passive, chromium-rich, oxide film that forms naturally on the surface of the steel. Although extremely thin at 1.5 nanometres (i.e. 1.5 x 10-9 metres) thick, this protective film is strongly adherent, and chemically stable (i.e. passive) under conditions which provide sufficient oxygen to the surface. The key to the durability of the corrosion resistance of stainless steels is that if the film is damaged it will normally self repair in the presence of oxygen. In contrast to mild steel type materials which suffer from general corrosion where large areas of the surface are affected, stainless steels which have a passive oxide film are normally resistant to general corrosion. Stainless steels should not be considered to be indestructible, the oxide film can be broken down under certain conditions and corrosion can result, this typically taking the form of pitting or crevice corrosion.

The stainless steel used in the manufacture of Vantrunk Cable Management Systems, components and accessories has excellent corrosion and oxidation resistance due to the high chromium content. Grades 1.4404 stainless steel is an austenitic stainless steel which incorporate nickel to strengthen the oxide film and improve performance in more aggressive environments. The addition of molybdenum to 1.4404 marine grade improves resistance to pitting corrosion. The austenitic stainless steels have

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excellent resistance to attack by acids, alkalis and other chemicals.

Stainless steels offer excellent performance at both high and low temperatures and, unlike some mild steels, are not susceptible to brittle fracture arising from impact at low temperature. Independent tests have shown that stainless steel cable ladders and trays can withstand a temperature of 1000°C for a period of 5 minutes without collapse (contact our Design Team for further details).

As the corrosion resistance of stainless steel is derived from the self-repairing oxide film it is important that the surface of the stainless steel remains uncontaminated, allowing the inherent corrosion resistance of the stainless steel to be maintained. Possible sources of contamination includes mild steel from cutting and drilling operations on site, and impingement of small particles created by welding and grinding of mild steel in close proximity to the stainless steel product. Care must be taken both during and after installation to avoid such contamination.

Stainless Steel Grade 1.4404 to BS EN 10088-2
(formerly marine grade 316 to BS 1449 Part 2)

Marine grade 1.4404 stainless steel is a corrosion resistant steel ideally suited for aggressive environments where severe conditions are prevalent, i.e. coastal and offshore applications. 1.4404 is a molybdenum-bearing austenitic stainless steel with high corrosion resistant properties, particularly to pitting and crevice corrosion. 1.4404 has excellent forming and welding characteristics. Post-weld annealing is not required with welding the material gauges that are used in the manufacture of the Speedway cable ladder system.

Mechanical Properties of Stainless Steel

Material Grade	Property		
	Proof Strength 0.2% Rp0.2 N/mm²	Tensile Strength Rm N/mm²	Elongated A_{80} %
1.4404	240 Min	530 to 680	40

2.1.3 Silicon-Rich Steel

Vantrunk Cable Management Systems, components and accessories can be manufactured using proprietary grades of silicon-rich material which are matched for performance and strength to the product and the intended application. Cable management products produced using silicon-rich steels require subsequent finishing on completion of manufacture to provide a means of corrosion protection.

Silicon-rich steels have high yield strengths, making these materials ideal for heavy duty applications. A particular property of these materials is the high silicon content which gives an affinity to attract thicker coatings of zinc when galvanized (see Finishes – Deep Galvanizing).

Material Grade	Property		
	Yield Strength Rp (N/mm²)	Tensile Strength Rm (N/mm²)	Elongated A %
S355J0WP	355 Minimum	480 Minimum	19
S355J2W	355 Minimum	510 - 680	15

Structural Steel Grade S355JoWP to BS EN 10025-5
S355JoWP is a weldable, high strength structural steel suitable for deep galvanizing. Ideal for environments where excellent corrosion resistance is required.

Structural steel grade S355J2W to BS EN 10025-5
S355J2W is a weldable, high strength structural steel with good galvanizing properties and Charpy impact rating at -20°C (and independantly tested to -45°C). Ideal for low temperature environments.

2.2 Finishes

The following are available for Vantrunk Cable Management Systems, components, and accessories:

Galvanizing
Hot dip galvanized to BS EN ISO 1461 (post-galvanized) GY, GA, & GK
Deep Galvanized to BS EN ISO 1461 (post-galvanized) GX

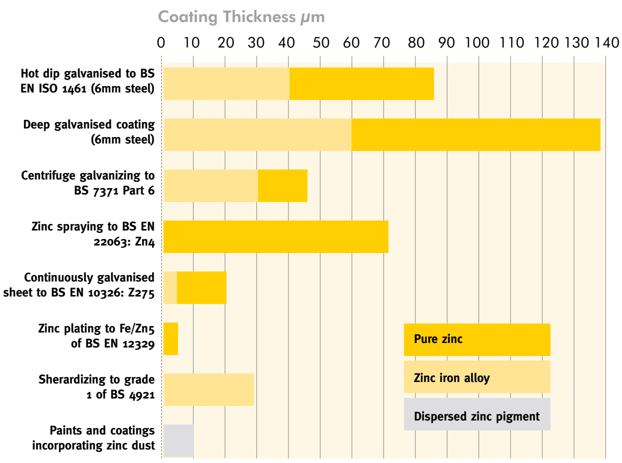
Coatings
Epoxy coated over mild steel EY & EA
Epoxy coated over hot dip galvanizing FY & FA

2.2.1 Galvanizing

The coating of steel using zinc, either before manufacture (pre-galvanized) or after manufacture (post-galvanized) is a cost effective and practical means of protecting the steel from corrosion. The zinc coating protects the steel in three ways. Firstly, the zinc coating weathers at a very slow rate giving a long and predictable life. Secondly, the zinc coating corrodes preferentially to provide sacrificial protection of any small areas of steel exposed through cutting, drilling, or accidental damage; scratches and small areas of damage are sealed by weathering products from the zinc. Thirdly, if the damaged area is larger, the sacrificial protection provided by the surrounding zinc prevents ‘creepage’ typically associated with other protective finishes such as paint coatings.

The thickness of the zinc coating is dependant on the method of application. The following table shows the typical zinc coating thicknesses for a number of galvanizing and related processes, and includes zinc based paints for comparison purposes.

Zinc coatings compared in terms of coating thickness



Hot Dip Galvanized Finishes to BS EN ISO 1461

The hot dip galvanizing process provides a continuous layer of zinc-iron alloys and zinc on the surface of the products manufactured in steel. The hot dip zinc coating provides a continuous barrier to moisture and other contaminants, thereby protecting the steel substrate.

During the galvanizing process, a layer of zinc-iron alloy develops on the surface of the steel product. When the steel product is withdrawn from the zinc bath, a layer of pure zinc is left on the zinc-iron alloy. The layer of pure zinc gives a newly galvanized item a bright finish. This bright finish will gradually fade as the surface layer of the zinc oxidises, leaving a uniform dull grey appearance.

The average amount of zinc which can be deposited on a product is expressed in terms of thickness and is measured in µm. The actual zinc coating thicknesses will vary depending on the thickness of the steel, the chemical composition of the steel, and the period of immersion within the zinc bath. BS EN ISO 1461 specifies a number of thickness ranges for products to be galvanized, each of which has a specified minimum average local reading and minimum mean average reading. Details are given in the following table.

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Zinc Coating Details to BS EN ISO 1461

Coating Weight & Thickness – Dipped Articles				
Article & Thickness	Local Coating (minimum)		Mean Coating (minimum)	
	Mass (g/m²)	Thickness μm	Mass (g/m²)	Thickness μm
Steel t ≥ 6mm	505	70	610	85
Steel 3mm ≥ t < = 6mm	395	55	505	70
Steel 1.5mm =≥ t < = 3mm	325	45	395	55
Steel t < 1.5mm	250	35	325	45
Castings t ≥= 6mm	505	70	575	80
Castings t < 6mm	430	60	505	70
Coating Weight & Thickness – Centrifuged Articles				
Article & it's Thickness	Local Coating (minimum)		Mean Coating (minimum)	
	Mass (g/m²)	Thickness μm	Mass (g/m²)	Thickness μm
Articles with threads:				
Diameter ≥ 6mm	395	55	505	70
Diameter <= 6mm	325	45	395	55
Other articles (including castings):				
t ≥= 3mm	325	45	395	55
t < 3mm	250	35	325	45

Deep Galvanizing to BS EN ISO 1461

The use of silicon-rich steels allows much heavier galvanized coatings to be obtained. Average coating thicknesses of two to three times that for mild steel can be achieved. It is for this reason that silicon-rich steels are termed 'reactive' steels and the galvanizing process 'deep galvanizing'.

The influence of the silicon does not increase consistently but rather follows a curve as shown in the following diagram. This curve gives average values and variations can be expected between different silicon-rich steels with the same silicon content but from different steel casts.

These variations are attributed to the fact that whilst the total silicon contents can be equal, the amount of silicon that is bound to oxygen within the steel can vary. More or less silicon is then dissolved in the steel, and it is only this amount that influences the reaction. The silicon can be unevenly distributed on the surface of the steel and this will lead to uneven variations in the coating thickness after galvanizing.

Another property of the galvanized coatings on silicon-rich steels is the colour. During the galvanizing process, a zinc layer builds up on the zinc-iron alloy layers which are adhering to the surface of the steel. The reaction rate can be such that this pure zinc layer is transformed completely to zinc-iron alloy before the article has had time to cool.

This results in a coating which can be much darker in appearance, varying in colour and thickness across the surface of the galvanized item. This appearance does not alter the corrosion resistance of the zinc coating. Due to the variations in coating thickness associated with deep galvanizing of silicon-rich materials it is normal to specify the finish as 'deep galvanized to twice the coating thickness specified by BS EN ISO 1461'.

Wet storage stain

Galvanized steel is protected from corrosion by a layer of zinc-iron alloys and a layer of pure zinc. After galvanizing, a protective zinc carbonate film forms over the surface of the zinc. The formation of this protective layer is only possible when the galvanized surface is exposed to free flowing air. Stacking freshly galvanized articles in contact with one another prevents the free circulation of air, and in wet or humid conditions, may result in the development of wet storage stain. Wet storage stain, often referred to as white rust, appears as a white, powdery covering. The white rust, comprising of zinc oxide and zinc hydroxide corrosion products, is voluminous and can appear to be more detrimental to the galvanized coating that it actually is.

Wet storage stain can be prevented by correct transport and storage provisions. For transportation over long distances, galvanized items should be protected by waterproof cover to prevent moisture ingress. For storage, galvanized items should be kept off the ground in a dry environment. If stacked in a potentially wet environment, the galvanized items should be separated from one another to provide free circulation of air. If possible, the stacking should be at an angle to facilitate drainage of water.

In normal use, light wet storage stain is not serious and does not reduce the life expectancy of the galvanized coating. The affected area should be dried and exposed to the atmosphere to allow the zinc to form a protective carbonate layer. The appearance of the wet storage stain will gradually fade to that of a normally weathered galvanized steel. Where more stubborn wet storage stain deposits are evident, these should be removed using a stiff bristle (non wire) brush and, if necessary, a cleaning solution should be used. Typical solutions would be ammonia A citric acid based clear such as Metsoak C4900 with a 10% dilution v/v, the cleaning solutions should be thoroughly rinsed off after treatment and the article allowed to dry.

Life expectancy of zinc coatings

The life expectancy of a zinc coating is largely determined by its thickness. Thicker coatings give longer life (the period to first maintenance). When exposed to atmosphere the zinc coating will weather and corrode, leading to a gradual diminution in the coating thickness. Under conditions of normal atmospheric exposure the level of corrosion is low and is typically at a rate which is between 1/10th and 1/40th of that of the steel base.

When subject to conditions of high humidity or condensation, the rate of corrosion of the zinc coating can be increased significantly.

The level of contamination in the atmosphere can also adversely affect the corrosion rate of the zinc coating. The most significant contaminant accelerating the corrosion rate of zinc is sulphur dioxide (SO_2). The resistance of zinc to atmospheric corrosion is dependent on the protective zinc carbonate film which forms on the surface of the zinc.

The sulphur dioxide reacts with moisture to destroy the protective film and this leads to the corrosion of the zinc coating.

Research undertaken by the Galvanizers Association has resulted in the publishing of a series of charts depicting the average atmospheric corrosion rate for zinc for the United Kingdom and Ireland. These charts indicate that the average local atmospheric corrosion rates for zinc have decreased, reflecting the general decrease in the levels of sulphur dioxide in the atmosphere.

Current atmospheric corrosion rates for zinc within the United Kingdom and the Republic of Ireland are given in the Zinc Millennium Map and are in the range of 0.5µm to 2.5µm per year (corrosion categories C2 – C3 to ISO 14713).

Please see overleaf page for Zinc Millennium map.

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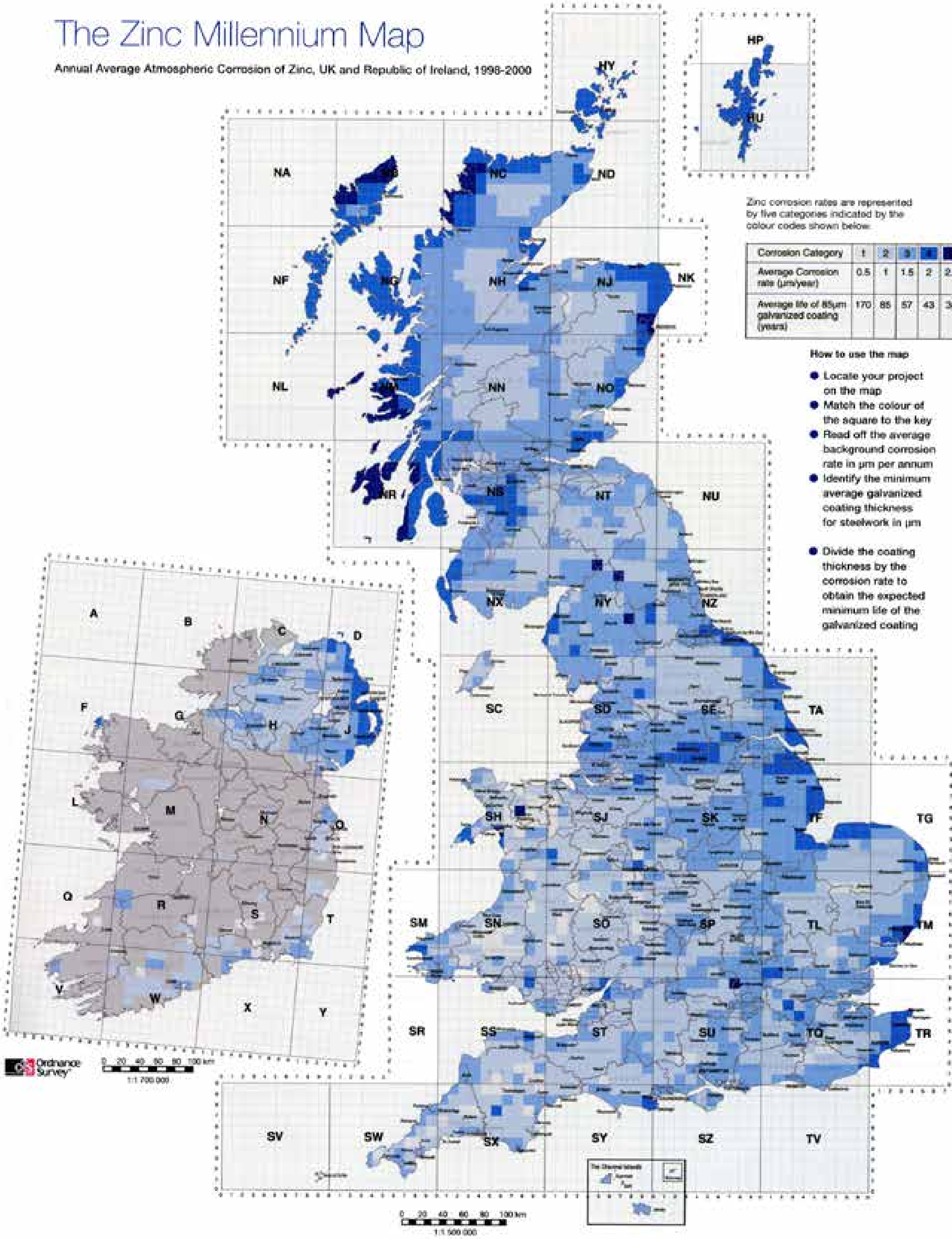
The Zinc Millennium Map

Annual Average Atmospheric Corrosion of Zinc, UK and Republic of Ireland, 1998-2000



Zinc corrosion rates are represented by five categories indicated by the colour codes shown below.

Corrosion Category	1	2	3	4	5
Average Corrosion rate (µm/year)	0.5	1	1.5	2	2.5
Average life of 85µm galvanized coating (years)	170	85	57	43	34

How to use the map

- Locate your project on the map
- Match the colour of the square to the key
- Read off the average background corrosion rate in µm per annum
- Identify the minimum average galvanized coating thickness for steelwork in µm
- Divide the coating thickness by the corrosion rate to obtain the expected minimum life of the galvanized coating

Acknowledgements

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- Mr Tom Shaw for consultancy services throughout the project and for application of the Thiessen method to the project data
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- Mr John Curtin (consultant) and Mr Michael Taylor (Britannia Zinc Limited) for valuable project assistance
- All those who provided sample sites for the project

ADAS Consulting and GA are grateful to Orange Plc for provision of survey sites in the UK and the Irish Electricity Supply Board for survey sites that allowed corrosion rates at key Irish locations to be included in the Zinc Millennium Map. Further studies are planned to extend survey coverage in the Republic of Ireland. For areas not yet covered, the rates indicated for comparable areas may be used as an indication of likely corrosion rates.

The corrosion rate for zinc is generally linear for a given local environment. This allows predictions of the life expectancy of a galvanized product, to first maintenance, based on the zinc coating thickness and the zinc corrosion rates given in the Zinc Millennium Map. For example, a hot dip galvanized product with a coating thickness of 55µm will last approximately 110 years in a location where the atmospheric corrosion rate of zinc is 0.5µm per year, and approximately 22 years in a location where the atmospheric corrosion rate is 2.5µm per year.

Further information regarding hot dip galvanizing and the Zinc Millennium Map can be obtained from the Galvanizers Association.

The Zinc Millennium Map provides specific information for the United Kingdom and Ireland. For other locations, reference can be made to BS EN ISO 14713 (Protection against corrosion of iron and steel in structures – Zinc and aluminium coatings – Guidelines).

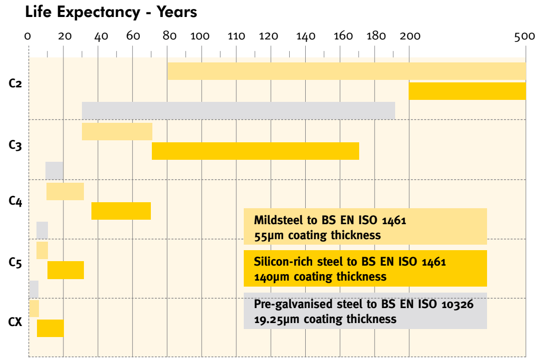
BS EN ISO 14713 provides general guidelines on corrosion rates for zinc in differing environmental conditions, details of which are given in the table below.

Category	Corrosion Rate µm/year	Environment	
C1	rate <= 0.1 Very Low	Indoor	Heated spaces with low humidity
		Outdoor	Dry or cold zone with very low pollution and wetness
C2	0.1 < rate <= 0.7 Low	Indoor	Varying temperature & relative humidity. Low condensation & pollution
		Outdoor	Temperate zone, atmospheric environment with low pollution e.g. rural areas, small towns.
C3	0.7 < rate <= 2 Medium	Indoor	Dry or cold zones, atmospheric environment with short time of wetness e.g. deserts, sub-arctic areas.
		Outdoor	Spaces with moderate frequency of condensation and pollution
C4	2 < rate <= 4 High	Indoor	Temperate zone, atmospheric environment with medium pollution or some effect of chlorides e.g. urban areas, coastal areas with low deposition of chlorides.
		Outdoor	Subtropical and tropical zones with an atmosphere with low pollution.
C5	4 < rate <= 8 Very High	Indoor	Spaces with high frequency of condensation and high pollution
		Outdoor	Temperate zone, atmospheric environment with high pollution or substantial effect of chlorides e.g. polluted urban areas, coastal areas without spray of salt water.
CX	8 < rate <= 25 Extreme	Indoor	Spaces with almost permanent condensation or extensive periods of humidity and very high pollution
		Outdoor	Subtropical and tropical zones (very high time of wetness), atmospheric environment with very high pollution, including accompanying pollution and/or strong effect of chlorides e.g. extreme industrial areas, coastal and offshore areas with occasional contact to salt spray.

The corrosion rates should be considered as an indication only and provide a broad means of estimating the life expectancy of a zinc coating. This information should be treated as a general guide and further information should be sought relating to the specific zinc corrosion rates at the installation site.

Using these broad corrosion rates, the following table shows the life expectancy of galvanized cable management products for corrosion categories C2 to C5.

Life Expectancy for Zinc Coated Products Based on Classification to BS EN ISO 14713



› 2.2.2 Coatings

A number of coatings have been used for the coating of cable management products. By far the most cost effective, versitile, and advantageous is epoxy. Epoxy coatings are based on thermosetting epoxy resins which are applied electrostatically as a powder spray which is cured and hardened in an oven. The powder spray application ensures complete and even coverage of the surface. Epoxy coatings give a thin, hard and durable finish which provides good chemical resistance, excellent adhesion, and coating flexibility. Epoxy coatings are available in a variety of colours. Black is supplied as standard unless otherwise requested.

Epoxy over Mild Steel

Epoxy coatings can be applied directly to mild steel to give a corrosion resistant finish. The steel products are subject to a degreasing treatment to remove all surface contaminants and then epoxy powder coated to a dry film thickness of 75 microns.

Epoxy over Hot Dip Galvanized Mild Steel

Whilst hot dip galvanizing provides a long lasting and cost effective means of protecting steel from corrosion, the performance of the zinc coating can be enhanced by the addition of an epoxy coating. This type of finish is referred to as a duplex coating. The duplex coating can be used to add colour for aesthetic or safety purposes and provide additional protection for the steel in aggressive environments. The epoxy provides resistance to chemical degradation, and the underlying layer of zinc prevents creepage under the epoxy coating. The hot dip galvanized steel products are treated by an acid etch, a chromate pre-treatment and then epoxy powder coated to a dry film thickness of 75 microns.

2.2.3 Passivated

Stainless steel is corrosion resistant because of the presence of a thin, dense, self-healing passive chromium-rich layer on the surface of the metal. This protective layer acts as a barrier between the metal and the environment and reduces the rate of dissolution of the metal. If this chromium oxide film is damaged the steel will, in most circumstances, oxidise and reform the protective layer (self-healing). When the surface of stainless steel is subject to mechanical treatments such as grinding or machining stresses, an increased roughness will occur in the outer surface layers damaging the oxide film, occasionally leaving impurities on the surface and preventing the passive film from reforming. This can also happen in general handling.

In addition, many grades of stainless steel are adversely affected by processes such as welding or heat treatment which can result in the formation of surface oxide films which can prevent the natural passive chromium oxide layer from forming. The heat discolouration marks found around the welds of stainless steel products is a form of oxide which does not necessarily adversely influence corrosion resistance unless the material is exposed to the most extremely aggressive environments e.g. when used for acid containment, etc. It should not be necessary to remove this discolouration in situations where the stainless steel offers satisfactory corrosion resistance for a particular installation.

If the passive oxide layer is damaged and the self-healing process does not occur the stainless steel will corrode, this will take the form of pitting, intercrystalline corrosion, or stress corrosion cracking. The rate of corrosion is accelerated in the presence of chloride compounds. Consequently, it is important to specify the correct grade of stainless steel, to use the correct welding techniques, and to avoid contamination with carbon steel during manufacturing processes. The use of 1.4404 marine grade stainless steel (316 grade) reduces the potential corrosion problems associated with the welding of stainless steel.

As standard, stainless steel Speedway Cable Ladder is treated by means of pickling and passivating. The pickling process removes the surface of the stainless steel by etching in a heated nitric/hydrofluoric acid solution. Pickling will remove surface debris, leaving the stainless steel clean and allowing the passive chromium oxide film to form; the surface of the stainless steel can then be described as being in the passive condition. A further treatment is then applied in which a solution of nitric acid is used to thicken the existing passive layer of chromium oxide whilst reducing the time taken to form the film. The entire process leaves the stainless steel with a uniform dull grey colour.

3. Classification to BS EN ISO 61537

For details of the classification of the Speedway Cable Ladder system and Vantrunk Cable Tray system, components and accessories to BS EN ISO 61537 (Cable tray systems and cable ladder systems for cable management) please refer to our Design Team. For details relating to the CE-marking of the Speedway Cable Ladder system, components and accessories, and to the details relating to the Technical File, please refer to our Design Team.

4. Reference Standards

The following is a list of the standards relating to the cable management products covered by this catalogue:

BS 729	Replaced by BS EN ISO 1461.
BS 1449 Part 1	Replaced by BS EN 10111, 10130 & 10025.
BS 1449 Part 2	Replaced by BS EN 10088-2.
BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods (formerly BS 729).
BS 2989	Replaced by BS EN 10147.
BS 6946	Specification for metal channel cable support systems for electrical installations.
ISO 9223	Corrosion of metals & alloys – Corrosivity of atmospheres.
BS EN 10025	Replaced by BS EN 10025-2
BS EN 10025-2	Hot rolled products of structural steels. Technical delivery conditions for nonalloy structural steels (formerly BS EN 10025:1993).
BS EN 10088-2	Stainless steels. Technical delivery conditions for sheet/plate and strip for general purposes (formerly BS 1449 Part 2).
BS EN 10111	Continuously hot rolled low carbon steel sheet & strip for cold forming. Technical delivery conditions.
BS EN 10130	Cold rolled low carbon flat products for cold forming. Technical delivery conditions.
BS EN 10147	Replaced by BS EN 10136:2004.
BS EN 10326	Continuously hot-dip coated strip and sheet of structural steels. Technical delivery conditions.
BS EN ISO 14713	Protection against corrosion of iron and steel in structures – Zinc and aluminium coatings – Guidelines.
BS EN 10327	Continuously hot dip coated strip & sheet of low carbon steels for cold forming. Technical delivery conditions.
BS EN 50085-1	Cable trunking and cable ducting systems for electrical installations. General requirements (formerly BS 4678 Part 1).
BS EN 61537	Cable tray systems & cable ladder systems for cable management.
NEMA VE 1	Metal Cable Tray Systems (also CSA International C22.2 No 126.1-98).
NEMA VE 2	Cable Tray Installation Guidelines.
BS EN 10346	Continously hot-dip coated strip & sheet of low carbon steels for cold forming. Technical delivery conditions.