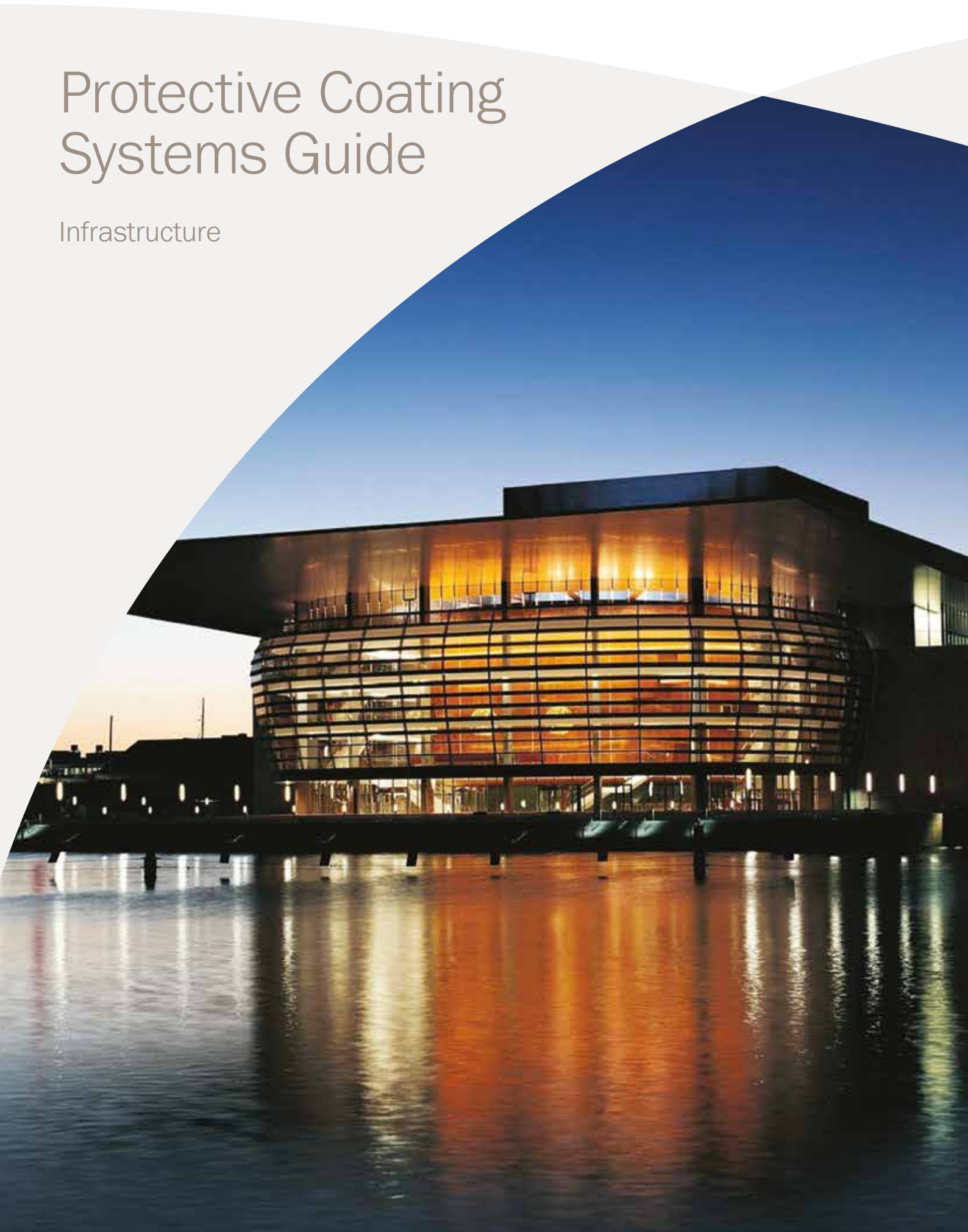


Protective Coating Systems Guide

Infrastructure



World-leading coatings supplier

Hempel was founded in 1915 and is today one of the world's leading manufacturers and suppliers of coating solutions. Our advanced coatings can be found on millions of surfaces around the globe.

From the world's longest bridges and tallest skyscrapers to airports, sports stadia and civil structures, our coatings protect your assets against corrosion in many different and challenging environments.

Our history is rooted in protective coatings for the extreme conditions experienced in the Marine and Protective industries, so you can be assured that we offer trusted technology, expert technical service and reliability.

With our vast expertise and knowledge, you know that by choosing Hempel, you are choosing a brand you can trust.

Tailored coating solutions

Our range of high performance protective coatings are designed to protect buildings in a number of ways.

Projects are analysed for specific requirements and our experienced advisors deliver systems that will protect against various elements, from changing temperatures and humidity, to the aging of structures and the threat of fire.

Our coatings incorporate advanced technologies designed to improve their effectiveness and longevity and can be specified for use on new buildings or as part of an on-going maintenance programme.

We provide advanced protection for all surfaces and substrates from the ground up.

Our range of coatings are combined into systems that address the specific needs of your projects:

- Abrasion and corrosion resistance
- Weather resistance
- Good gloss and colour retention
- Easy to clean and maintain
- Fire protection properties

Technical Support

At Hempel, we have more than 600 FROSIO/NACE certified coating advisors around the world ensuring our customers receive the exact application advice for their project and conditions

Experienced and dedicated, our technical service team is available to give you off and on site advice at every stage of your project, from initial specifications to final application. Globally renowned, they offer expert advice to ensure our solutions last as long as expected and that every application procedure is as fast and efficient as possible.



HEMPEL

Introduction

The purpose of this document is to help you select the best Hempel coating system to protect your structure against corrosion. All steel structures, facilities and installations exposed to the atmosphere, submerged under water or in soil, suffer because of corrosion. Consequently, they require protection from the harm caused by corrosion during their lifetime. Throughout this document, you will find important information regarding paint technology, criteria for the right paint selection and surface preparation requirements.

This document has been prepared in accordance with the latest edition of the International standard ISO12944 “Paints and varnishes – Corrosion protection of steel structures by protective paint systems”. Hempel’s guidelines and recommendations for coating protection technology are also included.

Outlined in this document are generic coating systems recommended by Hempel for different corrosive environments. It is in no way binding. If you would like specific information on your project, please contact your Hempel representative.



Selecting the right coating system

When selecting a coating system, it is important to define the conditions in which the structure, facility or installation is to operate. The environmental conditions and factors affecting corrosion will have an effect on:

- The selection of a coating system
- The total thickness of a coating system
- The surface preparation required
- Minimum and maximum recoating intervals

Corrosivity category	Environment examples	
	Exterior	Interior
C1 very low	-	Heated buildings with a clean atmosphere such as offices, shops, schools, hotels.
C2 low	Atmospheres contaminated to a small extent, mainly rural regions.	Buildings which are not heated, where condensation may occur e.g. storage facilities, sports hall.
C3 medium	Industrial and urban atmospheres with a low sulphur oxide (IV) contamination level. Inshore areas of low salinity.	Production halls to facilities humidity and certain air contamination e.g. foodstuff plants, laundries, breweries, dairies.
C4 high	Industrial areas and inshore areas of medium salinity.	Chemical plants, swimming pools, ship repair yards.
C5 very high	Industrial areas of high humidity and aggressive atmosphere and inshore areas of high salinity.	Buildings and areas of almost constant condensation and high contamination.
CX extreme*	Offshore areas of high salinity or industrial areas of extremely high humidity and aggressive atmosphere or subtropical and tropical areas.	Buildings and areas of almost constant condensation and aggressive contamination.

* New category that covers offshore Part 9.

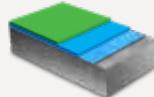
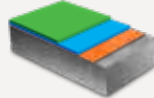
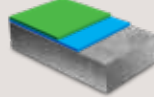
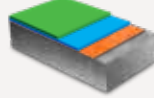
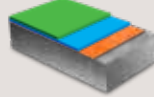
LOW – L	up to 7 years
MEDIUM – M	7 to 15 years
HIGH – H	15 to 25 years
VERY HIGH – VH	more than 25 years

For more information on the selection of right coating system based on ISO12944, please contact your local Hempel representative.

Hempel
coating systems

Recommended generic coating systems for various
corrosivity categories and other types of environments
(in accordance with ISO12944:2018)

Corrosion protection for structural steel

Corrosivity conditions	Coating System	Paint type	Product name	DFT (um)	Total DFT (um)
C3-M		Epoxy	Hempaprime Multi 500	120	120
		Polyurethane	Hempathane HS 55610	120	120
C3-H		Epoxy	Hempaprime Multi 500	150	200
		Polyurethane	Hempathane HS 55610	50	
C4-H		Zinc Epoxy	Hempadur Avantguard 550	75	200
		Polyurethane	Hempathane HS 55610	125	
		Epoxy	Hempaprime Multi 500	100	240
		Epoxy	Hempaprime Multi 500	100	
		Polyurethane	Hempathane HS 55210	40	200
		Zinc Epoxy	Hempadur Avantguard 550	40	
		Epoxy	Hempaprime Multi 500	100	
		Polyurethane	Hempathane HS 55610	60	
C5-M		Epoxy	Hempaprime Multi 500	180	240
		Polyurethane	Hempathane HS 55610	60	
C5-H		Zinc Epoxy	Hempadur Avantguard 750	50	260
		Epoxy	Hempaprime Multi 500	150	
		Polyurethane	Hempathane HS 55610	60	
C5-VH		Zinc Epoxy	Hempadur Avantguard 750	60	320
		Epoxy	Hempaprime Multi 500	180	
		Polyurethane	Hempathane HS 55610	80	

For more information on the selection of right coating system, please contact your local Hempel representative.

2014 World Cup Stadia

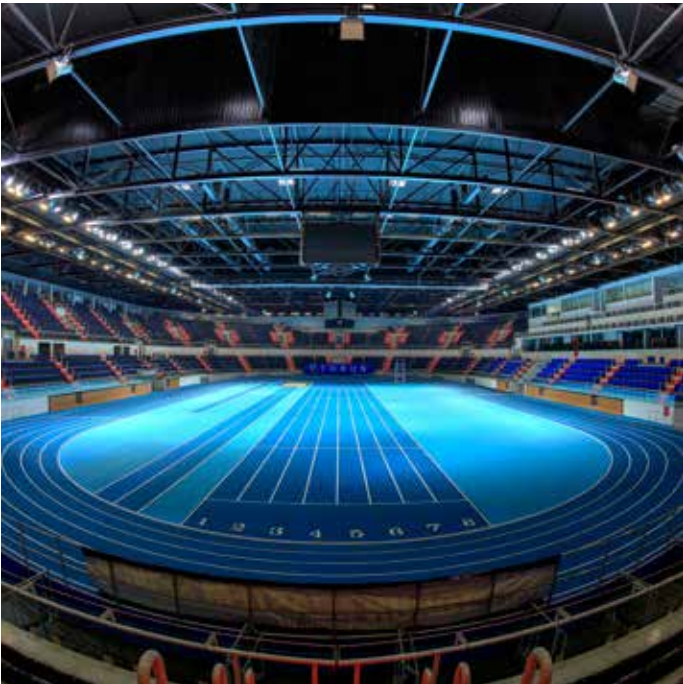
Brazil

The 2014 FIFA world cup officially kicked off on 12th June 2014 in Brazil. But the construction of the stadium preparation program had started three years before the official game.

The huge metal structures for three stadiums were manufactured and fully coated in Portugal, before being shipped to Brazil and assembled on-site. Our systems were chosen to resist the corrosive salty ocean crossing, the hard knocks that happen during construction and to protect the Brazilian climate for many years to come.

With a reputation among steel constructors as an extremely reliable product that combines excellent mechanical resistance with high productivity, Hempadur Fast Dry 15560 was integral to this durable coating system.

Arena Fonte Nova in Salvador da Bahia, with a capacity for 55,000 spectators, and coated with 40,000 litres of Hempel paint, was awarded the 2013 European Steel Design Award by ECCS (European Convention for Construction Steel work).



The Louvre Museum

Abu Dhabi

The innovative Louvre Abu Dhabi building, designed by Pritzker prize-winning architect Jean Nouvel, combines modern architecture and inspiration drawn from the region's traditions. The design reflects the desire to create a universal museum in which all cultures are brought together.

8000 tonnes of steelwork that form the domed roof needed protection against the corrosive salts from the sea of the Persian Gulf and the natural climate of Saadiyat island.

For this project, our customer chose a combination of our protective coatings to ensure the most durable and aesthetic finish for this striking structure.



Protecting a whole world of steel structures

From airports to train stations, schools to conference centres, stadiums to manufacturing facilities, our coatings protect different types of buildings and structures all over the world.

These include:

- **The Louvre**, U.A.E
- **VW Plant**, Russia
- **Singapore University of Technology & Design**, Singapore
- **Torun Sports Hall**, Poland
- **Metro Bus Shelters**, Argentina
- **Adnan Menderes Domestic Terminal Airport**, Turkey
- **Adler Railway Station**, Russia
- **Olympic Park and Train Station**, Russia
- **BTS Airport**, Slovakia
- **Guangzhou Railway Station**, China
- **Chengdu Terminal 2**, China
- **Kunming New International Airport**, China
- **Beijing International Airport T3**
- **Copenhagen Opera House**, Denmark
- **Audi Plant**, Mexico
- **Guangzhou Olympic Sports Centre**

Avantguard® for superior corrosion protection

Our patented Hempadur Avantguard zinc primers activate more zinc throughout the coating to give you superior corrosion protection and lower maintenance requirements. And, with best-in-class overcoating intervals, application is at least 33 per cent faster, too.

Give your assets superior corrosion protection. Hempadur Avantguard complies with NORSOK M-501 and is proven to be fast curing and easy to apply.

- Significantly reduced rust creep
- Improved mechanical strength for high crack resistance
- Easy to apply, even in high temperatures and humidity

Based on activated zinc technology, our patented Hempadur Avantguard coatings have been proven to deliver superior corrosion protection compared to key competitor zinc rich epoxy primers. This superiority has been independently proven by third party laboratory neutral salt spray tests according to ISO 9227. In this test, steel protected with Avantguard produced a lower evolution of rust creep than the competitors, assessed according to ISO 12944-6, when tested up to 3x the duration for C5 high environments. Avantguard's overcoating interval is a minimum of 33 percent faster than competitor zinc-rich epoxies when comparing product data sheets.

avantguard.hempel.com

 **HEMPEL**
Trust is earned

Intumescent fire protection for structural steel

Corrosivity conditions	Coating System	Paint type	Product name	DFT
C2-Interior Full WB system Optimised for 120mins of fire protection		WB epoxy	Hempadur 18500	75
		WB cellulosic intumescent	Hempafire Optima 500	Contact Hempel
		WB Acrylic	Hemucryl Enamel Hi-Build 58030	50
C3-Interior Optimised for 120mins of fire protection		Epoxy	Hempadur Fast Dry 17410/ Hempaprime Multi 500	100
		WB cellulosic intumescent	Hempafire Optima 500	Contact Hempel
		Polyurethane	Hempathane HS 55610	100
Up to C4 conditions Optimised for 60mins fire protection		Epoxy	Hempadur Fast Dry 17410 Hempaprime Multi 500	100 125
		cellulosic intumescent	Hempafire Pro 315	Contact Hempel
		Polyurethane	Hempathane HS 55610	100
Up to C4 conditions Optimised for 90mins fire protection		Epoxy	Hempadur Fast Dry 17410 Hempaprime Multi 500	100 125
		cellulosic intumescent	Hempacore One 43600	Contact Hempel
		Polyurethane	Hempathane HS 55610	100

For more information on the selection of right coating system, please contact your local Hempel representative.

Vienna International Airport

Vienna International Airport’s new Hangar No.7, a 7,000 square metre structure, is protected against fire with the help of Hempel Hempacore.

The building contractors not only wanted to be sure of a durable coating that would meet fire safety regulations, but easy to maintain and give a smart, long lasting finish. By choosing our tailored three coat system, they also achieved fast and efficient application, allowing Hangar No. 7 to be fully operational in less time.



Amsterdam Airport, Schiphol

Amsterdam Airport Schiphol is the main international airport in the Netherlands and the third-busiest airport in Europe with more than 71 million passengers during 2019. When the airport began an extensive expansion project, safety was top of the mind/ Portuguese coating application company Nanosteel was looking for a coating that offered reliable PFP (passive fire protection), fast-to-apply, and could be used for 6,000 tons of structural steel – regardless of the steel’s profile or the corrosion environment in which it would stand. Our solution was Hempafire Pro 315 Fast Dry, an advanced PFP coating that delivers excellent passive fire protection and is optimised to reduce cost and time during application.

Like other PFP coatings, Hempafire Pro 315 Fast Dry is applied in thin layers to structural steel. When exposed to fire, it expands to form an insulating char, which enables the steel to retain its loadbearing capacity for longer, giving extra time for evacuation and emergency response.



We work closely with our customers on every project, large or small

We are there to support every step, offering advice, support and inspiration - and solutions that provide superior protection and performance.

- **Arena Torun**, Poland
- **Audi Plant**, Mexico
- **Vigo AVE Railway station**
- **Warsaw Metro**
- **Domodedovo Airport, Terminal 2**
- **Hangar 7**, Vienna
- **Birmingham Children Hospital**, United Kingdom
- **Lakhta Centre**, Russia
- **Sakhir Conference Hall**, Bahrain
- **Porsche Centre**, Germany
- **DHL Hub**, Italy
- **Jordal Amfi Ice Hockey Stadium**, Norway
- **Maison de l'Ordre des Avocats**
(House of the Paris Bar Association)
- **Doha Marriott Hotel**, Qatar
- **La Samaritaine Renovation**, France



Cutting-edge research provides cutting-edge solutions

Hempel's new research and development centre is focused solely on life-saving passive fire protection products.

With fifteen research and development facilities around the world, Hempel works closely with you to provide the right solution for your project.

Our research and development teams are committed to continuous development of innovative and effective speciality coatings to give you durable protection in aggressive environments.

Hempel's new Centre of Excellence in Barcelona focuses on the research and development of coating products within the field of passive fire protection. This state-of-the art facility comprises 3,000 m² of laboratories, testing areas and offices and is staffed by a team of highly skilled technicians, applicators, fire testers, scientists and fire engineers.

As a global leader in the coatings industry, we are committed to developing and increasing a range of solutions that our customers can trust to protect their buildings and industrial installations. Our new Centre of Excellence R&D centre will enable us to accelerate this work, as we expand our passive fire protection product range in order to support our customers' specific requirements.



Corrosion protection for bridges

	Paint System	Paint type	Product name	DFT	Total DFT
Atmospheric		Zinc Epoxy	Hempadur Avantguard 750	50	260
		Epoxy	Hempaprime Multi 500	150	
		Polyurethane	Hempathane HS 55610	60	
Splash zone/ Immersed structures		Epoxy Glass Flake	Hempadur Multi Strength 35840	300	600
		Epoxy Glass Flake	Hempadur Multi-Strength 35840	300	

For more information on the selection of right coating system, please contact your local Hempel representative.

Concrete protection system

	Coating System	Paint type	Product name	DFT	Total DFT
General purpose – Light Duty use			Hempel's Sealer 05990	n.a.	260
		Epoxy	Hempadur Mastic 45881	100	
		Epoxy	Hempadur Mastic 45881	100	
		Polyurethane	Hempathane HS 55610	60	

Hempathane HS 55610 - Tested according to the requirements of Main Roads Western Australia 'Anti-graffiti Test Method' Section 5 Method for assessing the effectiveness of Non Sacrificial Anti-graffiti Coatings

Hempel's Epoxy Filler 35250 can be used as a filler, when required.

For more information on the selection of right coating system, please contact your local Hempel representative.



Your business, our expertise

For the ultimate in coating performance and project efficiency, choose Hempel Services.

Our global network of coatings experts has vast experience in project management, and Hempel Services gives you direct access to their knowledge. From specification and equipment to start-up and application, they offer support and guidance at every stage, so you can lower your costs while optimising results.

For specific fire protection expertise, our Passive Fire Protection - Business Technical Expertise function supports customers globally with technical advice, estimations and fire design to ensure the best solutions for their projects.

Optimise application process

From advice and troubleshooting to continuous support, we work with you every step of the way to maximise speed and productivity, reduce waste and eliminate rework.

Faster project delivery

We help streamline your maintenance work to reduce surface preparation time, increase application efficiency and mitigate

unexpected delays. This ensures your assets remain in operation for as long as possible.

Lower operational costs

By assessing all costs associated with your solution – from materials and equipment through to supply and storage – we identify cost-saving opportunities, giving you greater control over your working capital and keeping operational costs down.

Increase your revenue

We support you throughout your project to increase efficiency, eliminate bottlenecks and boost application speed. As a result, you benefit from additional in-service days – and can run your business without disruption.

Long durability

By ensuring the correct solution is used during newbuilding and subsequent maintenance work, we reduce the risk of damage or premature coating failure. This minimises long-term maintenance requirements and lowers your total building cost.

Calculation of practical paint consumption

There are various ways of expressing the relation between the theoretically calculated amount of paint needed to correctly match the specified dry film thickness and the practical amount of paint to be applied taking application conditions and skills into consideration. Hempel makes use of the term “consumption factor” to express this relation. Others use the term “loss” or “loss factor”. There is a relation between these terms and demonstrated further below. Irrespective of which factor is used, the calculated practical consumption will be similar. The consumption factor is always greater than 1 and this is strongly influenced by:

- The result of a spray application will generally result in an average DFT which is higher than the specified. Typical result gives average DFT being equal to 1.4x specified DFT. This is not real “loss” as such since the paint still ends up on the surface.
- The fact that some quantity of paint will not end up on the intended surface, for example, left-overs in the can, pumps and hoses, poor application practices, environmental factors and more. This may describe “loss” more correctly since the paint here is wasted.

Taking this into account, the resulting consumption factor may sometimes reach around 1.8. Total loss then is influenced by a combination of actual DFT and waste during paint application.

Useful Terms	Abbreviation	Unit
Volume Solids	VS	%
Dry film thickness	DFT	Microns
Area	A	m ²
Loss	L	%
Consumption factor	CF	-
Loss factor	LF	-
Theoretical Consumption	TC	Liters
Practical Consumption	PC	Liters
Theoretical Spreading Rate	TSR	m ² /liter
Practical Spreading Rate	PSR	m ² /liter

Formula	Sample result ¹	Formula	Sample result ¹
CF =	1.43	LF = $\frac{100 - L}{100}$	0.70
TC =	12.50	TSR = $\frac{VS * 10}{100}$	8.00
		PSR = $\frac{TSR}{CF}$	5.60
PC =	17.86	PC = $\frac{A}{PSR}$	17.86


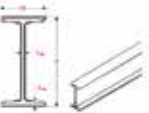

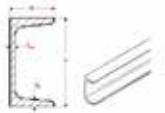

¹ Application area of 100 m². Loss %: 30 – VS %: 80 – DFT: 100 mic

Surface area estimates – beams and profiles

Plate Thickness	Area	Plate Thickness	Area
mm	m²/ton	mm	m²/ton
1	254.5	16	15.9
2	127.2	17	15.0
3	84.8	18	14.1
4	63.6	19	13.4
5	50.9	20	12.7
6	42.4	21	12.1
7	36.4	22	11.6
8	31.8	23	11.1
9	28.3	24	10.6
10	25.4	25	10.2
11	23.1	26	9.8
12	21.2	27	9.4
13	19.6	28	9.1
14	18.2	29	8.8
15	17.0	30	8.5

Note Area indicated is for both sides of the plate.

Pipes
Now included under simple shapes!

Designation / Shape	Size	Weight	Surface Area	
		kg/m	m²/m	m²/ton
 HEB EN 10025-1/2	100	20.8	0.567	27.3
	160	43.4	0.918	21.1
	220	72.8	1.270	17.4
	280	105.0	1.620	15.4
	360	145.0	1.850	12.7
	600	216.0	2.320	10.7
 INP EN 10025-1/2	80	6.06	0.303	50.0
	140	14.6	0.506	34.7
	200	26.7	0.709	26.5
	260	42.7	0.908	21.3
	340	69.3	1.150	16.6
	400	94.2	1.330	14.1
 HSS (Hot Formed) EN 10219:1997	20x20x2	1.10	0.075	68.2
	30x30x3	2.47	0.112	45.3
	40x40x4	4.39	0.150	34.1
	60x60x4	8.79	0.230	26.2
	80x80x4	9.41	0.310	33.0
 UNP EN 10025-1/2	80	8.82	0.313	35.5
	120	13.6	0.429	31.5
	160	19.2	0.545	28.4
	200	25.7	0.660	25.7
	240	33.8	0.776	23.0
	280	42.7	0.891	20.9
	400	73.2	1.18	16.1
 L PROFILE EN 10025-1/2	20x20x3	0.902	0.077	85.4
	25x25x4	1.49	0.097	65.1
	30x30x4	1.81	0.116	64.1
	40x40x4	2.46	0.155	63.0
	50x50x6	4.55	0.194	42.6
	50x50x9	6.60	0.194	29.4
	75x75x7	8.09	0.291	36.0
	75x75x10	11.3	0.291	25.8
	100x100x10	15.3	0.390	25.5
	150x150x15	34.4	0.586	17.0
	200x200x16	49.4	0.785	15.9

As a world-leading supplier of trusted coating solutions, Hempel is a global company with strong values, working with customers in the protective, marine, decorative, container and yacht industries. Hempel factories, R&D centres and stock points are established in every region.

Across the globe, Hempel's coatings protect surfaces, structures and equipment. They extend asset lifetimes, reduce maintenance costs and make homes and workplaces safer and more colourful. Hempel was founded in Copenhagen, Denmark in 1915. It is proudly owned by the Hempel Foundation, which ensures a solid economic base for the Hempel Group and supports cultural, social, humanitarian and scientific purposes around the world.

Regional Main Offices

Singapore (Regional HQ)

Phone : +65 6799 8383

Email : info.sg@hempel.com

Puchong, Malaysia

Phone : +603 8063 3037

Email : info.my@hempel.com

Bekasi, Indonesia

Phone : +62 218 843 385

Email : indonesia.id@hempel.com

Melbourne, Australia

Phone : +61 3 8369 4900

Email : sales.au@hempel.com

Mumbai, India

Phone : +91 022 6139 2555

Email : info.in@hempel.com

Ho Chi Minh City, Vietnam

Phone : +8428 3910 2050

Email : sales.vn@hempel.com