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carboline®
Coatings - Linings - Fireproofing

ISO 12944

Standard

Corrosion Protection of Steel Structures by Protective Paint Systems

January 2021

Solving our customers' problems is how we got started and after 70 years, it's still our focus at Carboline.

1947

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Our customers can be confident that behind every sale is a team of some of the most well-respected members of the industry, dedicated and determined to make your project a success.

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ISO Standard

International standard regarding Paints and Varnishes – Corrosion Protection of Steel Structures by Protective Paint Systems

This standard is intended to assist the user in the best practice for protecting steel surfaces from corrosion. It helps in the proper selection of coatings for different environmental exposures, from the identification of exposures to surface preparation to the testing of coatings and specification writing. The standard also covers the environmental classifications; and, in a general nature, helps define the types of exposures that a coating system might be exposed to. These classifications are listed below.

C1 & C2
Rural areas, low pollution; or interior controlled environment

C3
Urban or light industrial environments with moderate SO_2 levels; or process areas of high humidity (or frequent washing)

C4
Medium to high corrosion environment for mostly land based structures

C5M*
High corrosion environment in coastal and related marine structures

C5I*
High corrosion industrial exposures with high humidity and aggressive atmospheres (fumes/spill)

C5
High to severe corrosion environment in the land-based and coastal structures

CX
Extreme industrial areas, offshore, and marine areas

*C5M and C5I are being phased out in the period of March 2018-2023 and are being replaced with C5-High.

Differences between 1998 & 2018

Changes to corrosion categories:

The old C5-I and C5-M categories have been replaced with C5 High for harsh onshore categories and CX for offshore and marine categories. The CX category and its testing requirements are detailed under the ISO 12944-9 part. There is also the addition of a fourth immersion category, IM4, which covers immersed structures in the sea or brackish water protected by cathodic protection. The new ISO 12944 standard has incorporated the cyclic aging testing method traditionally used in the ISO 20340 testing protocol for the C4-Very High, C5-High, and C5-Very High categories, in addition to the traditional testing regimes used in the old ISO 12944 standard. The number of cycles varies depending on the corrosivity levels. The new standard incorporates minimum dry film thicknesses for individual coats and total system in effort to improve performance and longevity - for more information check Table B.2 in ISO 12944-5 (2018)

CATEGORY	CORROSIVITY	12944:1998	12944:2018
C1	Very low	Heated buildings	Dry or cold with very low pollution
C2	Low	Low levels of pollution	Temperate low pollution
C3	Medium	Urban and industrial atmospheres, moderate pollution or low salinity	Temperate, medium pollution, tropical low pollution
C4	High	Industrial areas or coastal areas with moderate salinity	Temperate with high pollution, tropical with moderate pollution
C5-I	Very high	Industrial, high humidity, aggressive atmosphere	N/A
C5-M	Very high	Coastal and offshore areas with high salinity	N/A
C5	Very high	N/A	Temperate and subtropical with very high pollution and/or significant chloride effects
CX	Extreme	N/A	Extreme industrial areas, offshore areas
IM1	Fresh water	River installations and hydro plants	River installations and hydro plants
IM2	Sea or brackish water	Harbour areas with structures and offshore structures	Immersed structures without cathodic protection
IM3	Soil	Buried structures	Buried structures
IM4	Sea or brackish water with cathodic protection	N/A	Immersed structures with cathodic protection

Changes to durability categories:

The Low, Medium and High categories remain, but they are joined by the Very High. The durations listed below are directly related to the level of corrosivity in each environment.
The duration range below and in the following pages is to estimate years of service but by no means should be considered a warranty or a guarantee of performance. For more details, please contact your Carboline representative.

DURABILITY CATEGORY	12944:1998	12944:2018
Low (L)	2-5 years	Up to 7 years
Medium (M)	5-15 years	7-15 years
High (H)	More than 15 years	15-25 years
Very High (VH)	–	More than 25 years

Changes to paint systems:

The dry film thicknesses and paint systems now include a minimum number of coats per coating type or technology and specify a minimum dry film thickness for the total system per corrosion category. See the following coating systems to see which systems to specify. The standard now includes the capacity to accept new innovative coating technologies if performance can be demonstrated by 3rd party testing and field trials.

Changes to laboratory test methods:

Up to C4 High, the test methods have not changed. However, for C4 Very High, C5 High, and C5 Very High, cyclic testing has been introduced to replicate field conditions better.

<table>
<tr><th></th><th>C3</th><th>C4</th><th>C5</th><th>CX</th></tr>
<tr><td>LOW (<7 YEARS)</td><td colspan="2" rowspan="2">Non-cyclic testing Durations as 1998 (E) revision ISO 6270 / ISO 9227</td><td rowspan="2">Non-cyclic testing: linear durations TBC ISO 6270 / ISO 9227</td><td>N/A</td></tr>
<tr><td>MEDIUM (7-15 YEARS)</td><td>N/A</td></tr>
<tr><td>HIGH (15-25 YEARS)</td><td colspan="2">Phased introduction of Cyclic ageing testing: 10 cycles / 1680 hours</td><td>N/A</td></tr>
<tr><td>VERY HIGH (25+ YEARS)</td><td>Non-cyclic testing durations as 1998 (E)</td><td>Phased introduction of Cyclic ageing testing: 10 cycles / 1680 hours</td><td>Cyclic ageing testing: 16 cycles / 2688 hours</td><td>Cyclic ageing testing: 25 cycles / 4200 hours</td></tr>
</table>

C3 High (Durability years 15-25)**:**

Urban or light industrial environments with moderate SO_2 levels; or process areas of high humidity (or frequent washing)

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Zinc Rich Epoxy	Carbozinc 858	**7 mils (175 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890	
Inorganic Zinc Silicate	Carbozinc 11	**7 mils (175 microns)**
Epoxy Polyamide	Carboguard 60	
Zinc Rich Epoxy	Carbozinc 858	**7 mils (175 microns)**
Epoxy Polyamide	Carboguard 60	
Epoxy Phenalkamine	Carboguard 635	**8 mils (200 microns)**
Epoxy Phenalkamine	Carboguard 635	
Epoxy Phenalkamine	Carbomastic 615	**8 mils (200 microns)**
Epoxy Phenalkamine	Carbomastic 615	
Inorganic Copolymer	Thermaline Heat Shield	**9 mils (225 microns)**
Inorganic Copolymer	Thermaline Heat Shield	
Cycloaliphatic Amine Epoxy	Carboguard 890	**8 mils (200 microns)**
Reinforced Zinc-Rich Primer	Carbozinc 808	**7 mils (175 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890	
Inorganic Zinc Silicate	Carbozinc 11	**7 mils (175 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890	
Aliphatic Polyaspartic	Carboquick 200	**9 mils (225 microns)**
Modified Siloxane Hybrid	Carboxane 2000	**6 mils (150 microns)**
Modified Siloxane Hybrid	Carboxane 2000 Satin	**6 mils (150 microns)**
Modified Siloxane Hybrid	Carboxane 2100 FC	**6 mils (150 microns)**

The durability range is not a "guarantee time." Durability is a technical consideration/planning parameter that was developed by the ISO 12944 Standards Committee that can help the owner set up a maintenance program.

C4 Medium (Durability years 7-15)**:**

Medium to high corrosion environment for mostly land based structures

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Modified Siloxane Hybrid	Carboxane 2000	**6 mils (150 microns)**
Modified Siloxane Hybrid	Carboxane 2000 Satin	**6 mils (150 microns)**
Modified Siloxane Hybrid	Carboxane 2100 FC	**6 mils (150 microns)**

The durability range is not a "guarantee time." Durability is a technical consideration/planning parameter that was developed by the ISO 12944 Standards Committee that can help the owner set up a maintenance program.

C4 High (Durability years 15-25)**:**

Medium to high corrosion environment for mostly land based structures

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Zinc Rich Epoxy	Carbozinc 858	**9 mils (225 microns)**
Epoxy Phenalkamine	Carboguard 635	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Galvanizing	Hot Dip Galvanized	**7 mils (175 microns)**
Epoxy Phenalkamine	Carboguard 635	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Phenalkamine Epoxy	Carboguard 690	**7 mils (175 microns)**
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Zinc Rich Epoxy	Carbozinc 858	**8 mils (200 microns)**
Epoxy Polyamide	Carboguard 60	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Organic Zinc-Rich Epoxy	Carbozinc 859	**8 mils (200 microns)**
Epoxy Polyamide with Corrosion Inhibitor (Zinc Phosphate)	Carboguard 893 SG	
Epoxy Polyamide	Carboguard 60	**8 mils (200 microns)**
Epoxy Polyamide	Carboguard 60	
Reinforced Zinc-Rich Primer	Carbozinc 808	**7 mils (175 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890	
Zinc-Rich Epoxy	Carbozinc 859 VOC	**11 mils (275 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890 LT	
Zinc-Rich Epoxy	Carbozinc 859	**12 mils (300 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890	
Aluminum-Filled Phenalkamine Epoxy Mastic	Carbomastic 615 AL	**10 mils (250 microns)**
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	

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C5M Medium (Durability years 7-15):

High corrosion environment in coastal and related marine structures

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Inorganic Copolymer	Thermaline Heat Shield	**9 mils (225 microns)**
Inorganic Copolymer	Thermaline Heat Shield	

The durability range is not a "guarantee time." Durability is a technical consideration/planning parameter that was developed by the ISO 12944 Standards Committee that can help the owner set up a maintenance program.

C5M (Marine) High (Durability years 15-25):

High corrosion environment in coastal and related marine structures

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Inorganic Zinc Silicate	Carbozinc 11	**12 mils (300 microns)**
Inorganic Silicate	Thermaline 4000	
Zinc-Rich Epoxy	Carbozinc 859 VOC	**14 mils (350 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890 VOC	
Aliphatic Acrylic-Polyester Polyurethane	Carbothane 133 MC	
Inorganic Zinc Silicate	Carbozinc 11	**3 mils (74 microns)**
Inorganic Zinc Silicate	Carbozinc 11	**7 mils (175 microns)**
Inorganic Ethyl Silicate	Carbozinc Finish	

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C5I Low (Durability years <7)**:**

High corrosion industrial exposures with high humidity and aggressive atmospheres (fumes/spill)

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Zinc-Rich Epoxy Primer	Carbozinc 8701	**10 mils (250 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890 LT	
Aliphatic Polyurethane	Carbothane 8812	
Flake-Reinforced Phenalkamine Epoxy Zinc	Carbozinc 608 HB	**13 mils (325 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890	
Flake-Reinforced Phenalkamine Epoxy Zinc	Carbozinc 608 HB	**10 mils (250 microns)**
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	

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C5I Medium (Durability years 7-15)**:**

High corrosion industrial exposures with high humidity and aggressive atmospheres (fumes/spill)

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Zinc-Rich Epoxy Primer	Carbozinc 8701	**10 mils (250 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890 LT	
Aliphatic Polyurethane	Carbothane 8812	
Inorganic Zinc Silicate	Carbozinc 11	**11 mils (275 microns)**
Epoxy Polyamide	Carboguard 60	
Solvent Based Organic Zinc-Rich Epoxy	Carbozinc 858	**11 mils (275 microns)**
Epoxy Polyamide	Carboguard 60	
Epoxy Polyamide	Carboguard 60	**17 mils (425 microns)**
Epoxy Polyamide	Carboguard 60	

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C5I High (Durability years 15-25)**:**

High corrosion industrial exposures with high humidity and aggressive atmospheres (fumes/spill)

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Two-Component, Zinc-Rich Epoxy Primer	Carbozinc 8701	**10 mils (250 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890 LT	
Two Component, Acrylic, Aliphatic Polyurethane.	Carbothane 8812	
Phenalkamine epoxy	Carbomastic 615	**20 mils (500 microns)**
Phenalkamine epoxy	Carbomastic 615	
Zinc-Rich Epoxy	Carbozinc 859 VOC	**14 mils (350 microns)**
Cycloaliphatic Amine Epoxy	Carboguard 890 VOC	
Aliphatic Acrylic-Polyester Polyurethane	Carbothane 133 MC	

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C5 High (Durability years 15-25)**:**

High to severe corrosion environment in land-based and coastal structures

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Zinc Rich Epoxy	Carbozinc 858	**11 mils (275 microns)**
Epoxy Polyamide	Carboguard 60	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Inorganic Zinc Silicate	Carbozinc 11	**11 mils (275 microns)**
Epoxy Polyamide	Carboguard 60	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Aluminum-Filled Phenalkamine Epoxy Mastic	Carbomastic 615 AL	**12 mils (300 microns)**
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Zinc Rich Epoxy	Carbozinc 858	**11 mils (275 microns)**
Phenalkamine Epoxy	Carboguard 690	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Phenalkamine Epoxy	Carboguard 690	**12 mils (300 microns)**
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
	Galvanized	**9 mils (225 microns)**
Phenalkamine Epoxy	Carboguard 690	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	
Zinc Rich Epoxy	Carbozinc 858	**11 mils (275 microns)**
Epoxy Phenalkamine	Carboguard 635	
Aliphatic Acrylic Polyurethane	Carbothane 134 HG	

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CX Extreme (Durability years 15-25)**:**

Extreme industrial areas, offshore, and marine areas

GENERIC TYPE	COATING SYSTEM	TOTAL DFT (µm)
Zinc Rich Epoxy	Carbozinc 858	**14 mils (350 microns)**
Epoxy Mastic	Carbomastic 15	
Epoxy Polyamide	Carboguard 60	
Acrylic Epoxy	Carbocrylic 1295 HS	
Zinc Rich Epoxy	Carbozinc 859	**13 mils (325 microns)**
Epoxy Polyamide	Carboguard 60	
Inorganic Zinc Silicate	Carbozinc 11 HS	**18 mils (450 microns)**
Epoxy Polyamide	Carboguard 60	
Epoxy Polyamide	Carboguard 60	
Acrylic Aliphatic Urethane	Carbothane 134 HG	
Inorganic Zinc Silicate	Carbozinc 11	**17 mils (425 microns)**
Epoxy Polyamide	Carboguard 60	
Epoxy Polyamide	Carboguard 60	
Acrylic Aliphatic Urethane	Carbothane 134 HG	
Inorganic Zinc Silicate	Carbozinc 11 FC	**17 mils (425 microns)**
Epoxy Phenalkamine	Carboguard 635	
Epoxy Phenalkamine	Carboguard 635	
Acrylic Aliphatic Urethane	Carbothane 134 HG	
Inorganic Zinc Silicate	Carbozinc 11 HS	**14 mils (350 microns)**
Epoxy Polyamide	Carboguard 60	
Acrylic Aliphatic Urethane	Carbothane 134 HG	
Inorganic Zinc	Carbozinc 11	**13 mils (325 microns)**
Epoxy Polyamide	Carboguard 60	
Acrylic Aliphatic Urethane	Carbothane 134 HG	
Zinc Rich Epoxy	Carbozinc 859	**13 mils (325 microns)**
Epoxy Polyamide	Carboguard 60	
Acrylic Aliphatic Urethane	Carbothane 134 HG	

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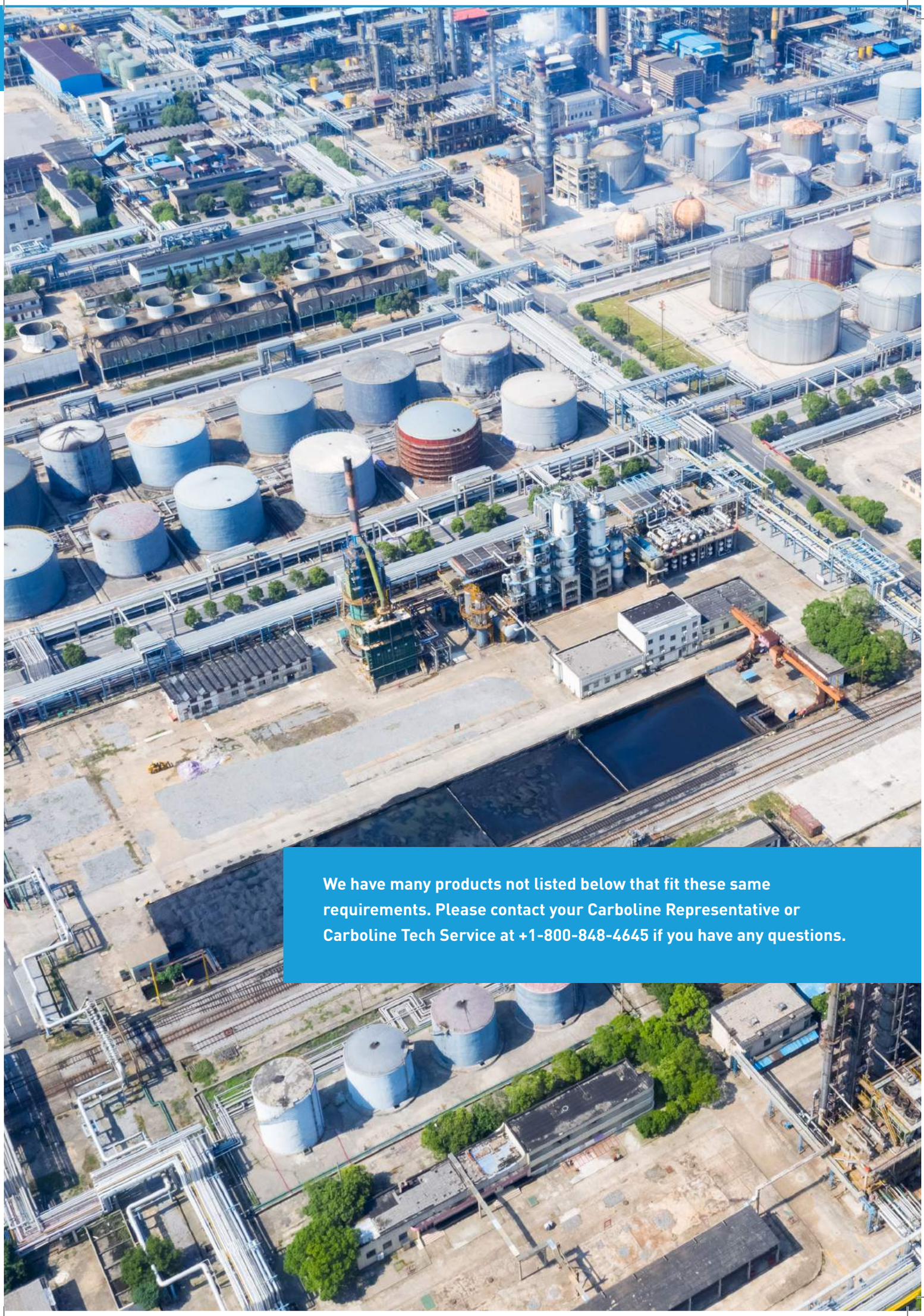

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