

# NORSOK

## Standard M-501

Global System Guide





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## **NORSOK Standard M-501 is a standard written for the offshore industry to qualify and otherwise specify coating systems to protect offshore structures.**

The standard was originally developed for the North Sea oil and gas market, but it has been globally accepted and used as the most predictive test standard for offshore service. The standard has undergone revisions over the years, with Edition 6 being the most current version. However, certain pre-qualified systems from earlier versions are still commonly used since the requirements (in many cases) were left unchanged.

The NORSOK standard accepts and utilizes several recognized global evaluation and testing methods, adding provisions deemed necessary to fill the broad corrosion protection needs of the petroleum industry, focusing on the marine and offshore environments. These protocols are globally recognized for their scope and applicability to the protection of offshore structures with regard to the selection of coating materials, surface preparation, application procedures, and inspection during construction and installation of offshore structures and associated facilities.

NORSOK M-501 describes nine separate coating systems. Some have subsystems, five of which must be “pre-qualified,” which means they must be rigorously tested by a third party and must meet minimum performance requirements. The remaining four coating systems do not require “pre-qualification.”

The systems outlined in this guide are Carboline coating systems that have been pre-qualified or otherwise recommended for each specific service.





# Coating System No. 1

**Service:** Carbon steel operating up to 120°C / 248°F

**Applications:** Structural steel

Exteriors of equipment, vessels, piping and uninsulated valves

| SYSTEM TYPE                                  | PRE-QUALIFIED SYSTEMS                     | DFT (MICRONS) | PRODUCT DESCRIPTION             |
|----------------------------------------------|-------------------------------------------|---------------|---------------------------------|
| Zinc-free systems / Urethane topcoat*        | Carbomastic 15                            | 150           | Epoxy amine                     |
|                                              | Carbomastic 15                            | 150           | Epoxy amine                     |
|                                              | Carbothane 134 HG                         | 60            | Acrylic polyurethane            |
| Zinc-free systems / Isocyanate-free topcoat* | Carbomastic 19 AL                         | 100           | Cycloaliphatic amine epoxy      |
|                                              | Carbomastic 19 AL                         | 100           | Cycloaliphatic amine epoxy      |
|                                              | Carboxane 2000 TC                         | 80            | Siloxane modified multi-polymer |
| Inorganic zinc / Epoxy / Urethane topcoat    | Carbozinc 11                              | 75            | Inorganic zinc primer           |
|                                              | Carboguard 893                            | 130           | Cycloaliphatic-amine epoxy      |
|                                              | Carbothane 134 HG                         | 75            | Acrylic polyurethane            |
|                                              | Carbozinc 11                              | 90            | Inorganic zinc primer           |
|                                              | Carboguard 890 LT                         | 175           | Cycloaliphatic-amine epoxy      |
|                                              | Carbothane 134 HG                         | 60            | Reactive acrylic                |
|                                              | Carbozinc 11                              | 90            | Inorganic zinc primer           |
|                                              | Carboguard 893 SG (LT)                    | 150           | Epoxy polyamide                 |
|                                              | Carbothane 134 HG                         | 75            | Acrylic polyurethane            |
| Organic zinc / Epoxy / Urethane topcoat      | Carbozinc 858                             | 75            | Zinc-rich epoxy                 |
|                                              | Carbomastic 15 LT                         | 130           | Modified epoxy mastic           |
|                                              | Carbothane 134 HP <sup>2</sup> (fka: 834) | 75            | Acrylic aliphatic polyurethane  |
|                                              | Carbozinc 858                             | 75            | Zinc-rich epoxy                 |
|                                              | Carboguard 60                             | 175           | Epoxy polyamide                 |
|                                              | Carbothane 134 HG                         | 60            | Acrylic polyurethane            |
|                                              | Carbozinc 858                             | 75            | Zinc-rich epoxy                 |
|                                              | Carboguard 893                            | 175           | Cycloaliphatic-amine epoxy      |
|                                              | Carbothane 134 HG                         | 60            | Acrylic polyurethane            |
|                                              | Carbozinc 858                             | 75            | Zinc-rich epoxy                 |
|                                              | Carboguard 690                            | 175           | Epoxy phenalkamine              |
|                                              | Carbothane 134 HG                         | 60            | Acrylic polyurethane            |

| SYSTEM TYPE                                      | PRE-QUALIFIED SYSTEMS  | DFT (MICRONS) | PRODUCT DESCRIPTION             |
|--------------------------------------------------|------------------------|---------------|---------------------------------|
| Inorganic zinc / Epoxy / Isocyanate-free topcoat | Carbozinc 11           | 75            | Inorganic zinc primer           |
|                                                  | Carboguard E19         | 30            | Epoxy polyamide primer          |
|                                                  | Carbomastic 18 FC      | 130           | Modified epoxy                  |
|                                                  | Carboxane 2000 Topcoat | 75            | Siloxane modified multi-polymer |
|                                                  | Carbozinc 11           | 75            | Inorganic zinc primer           |
|                                                  | Carboguard 893         | 130           | Cycloaliphatic-amine epoxy      |
|                                                  | Carbocrylic 1295 HS    | 75            | Reactive acrylic                |
|                                                  | Carbozinc 11           | 75            | Inorganic zinc primer           |
|                                                  | Carboguard E19         | 30            | Epoxy polyamide primer          |
|                                                  | Carbomastic 18 FC      | 130           | Modified epoxy                  |
|                                                  | Carbocrylic 1295 HS    | 75            | Reactive acrylic                |
|                                                  | Carbozinc 11 FC        | 75            | Inorganic zinc primer           |
|                                                  | Carboguard E19         | 30            | Epoxy polyamide primer          |
|                                                  | Carbomastic 18 FC      | 130           | Modified epoxy                  |
|                                                  | Carbocrylic 1295 HS    | 75            | Reactive acrylic                |
|                                                  | Carbozinc 11 FC        | 75            | Inorganic zinc primer           |
|                                                  | Carboguard E19         | 30            | Epoxy polyamide primer          |
|                                                  | Carbomastic 18 FC      | 130           | Modified epoxy                  |
|                                                  | Carboxane 2000 Topcoat | 75            | Siloxane modified multi-polymer |
|                                                  | Carbozinc 11 FC        | 75            | Inorganic zinc primer           |
|                                                  | Carboguard 60          | 150           | Epoxy polyamide                 |
|                                                  | Carbocrylic 1295 HS    | 75            | Reactive acrylic                |
| Organic zinc / Epoxy / Isocyanate-free topcoat   | Carbozinc 858          | 75            | Zinc-rich epoxy                 |
|                                                  | Carbomastic 15 LT      | 130           | Modified epoxy mastic           |
|                                                  | Carboxane 2000 Topcoat | 75            | Siloxane modified multi-polymer |
|                                                  | Carbozinc 858          | 75            | Zinc-rich epoxy                 |
|                                                  | Carbomastic 18 FC      | 130           | Modified epoxy                  |
|                                                  | Carbocrylic 1295 HS    | 75            | Acrylic-epoxy                   |
|                                                  | Carbozinc 858          | 75            | Zinc-rich epoxy                 |
|                                                  | Carbomastic 18 FC      | 130           | Modified Epoxy                  |
|                                                  | Carboxane 2000 Topcoat | 75            | Siloxane modified multi-polymer |
|                                                  | Carbozinc 858          | 75            | Zinc-rich epoxy                 |
|                                                  | Carboguard 893         | 130           | Cycloaliphatic-amine epoxy      |
|                                                  | Carboxane 2000 Topcoat | 60            | Siloxane modified multi-polymer |

\* The NORSOK M-501 standard requires zinc-rich primer as the first coat in System 1 qualification. Although this zinc-free system is not in accordance to the guidelines of the NORSOK M-501 standard, it has been tested and passed in accordance to the testing protocol of that standard (ISO 20340 testing protocol).



# Coating System No. 2A & No. 2B

**(Pre-qualification required for 2B topcoats: must have been pre-qualified under a System 1 test)**

**Service:** All carbon steel operating up to 120°C / 248°F with:

**System 2A:** Thermal spray aluminum (or alloys of aluminum)

**System 2B:** Thermal spray zinc (or alloys of zinc)

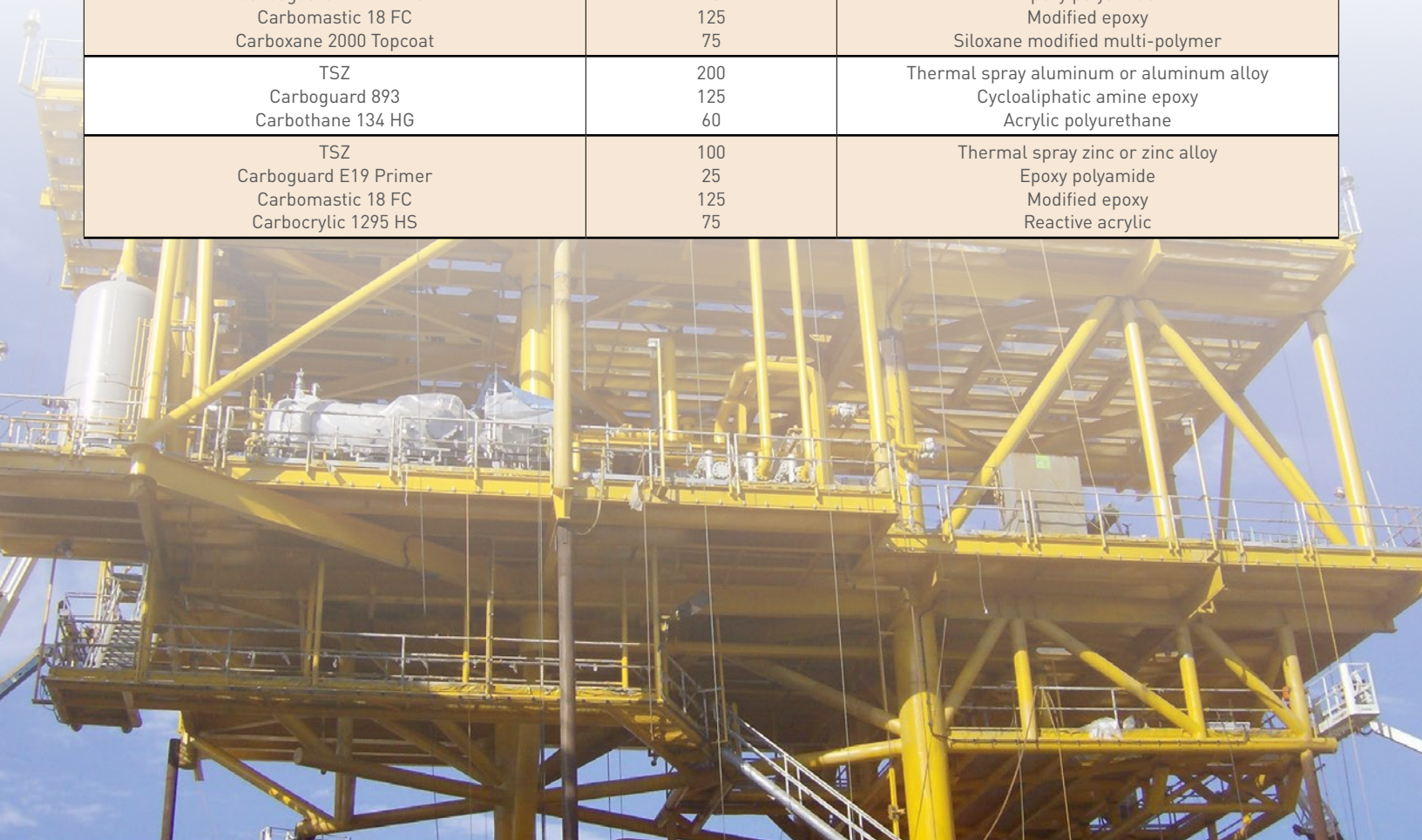
**Applications:** All insulated surfaces of tanks, vessels, piping:

**Flare booms and crane booms**

**(Optional):** Underside of bottom deck including piping, jacket above splash zone, lifeboat stations

| RECOMMENDED SYSTEMS (SYSTEM 2A)                                             | DFT (MICRONS)              | PRODUCT DESCRIPTION                                           |
|-----------------------------------------------------------------------------|----------------------------|---------------------------------------------------------------|
| TSA (operating at <120°C / 248°F)<br>Carboguard 60 or Carboguard E19 Primer | 200<br>As needed           | Thermal spray aluminum or aluminum alloy<br>Epoxy polyamide   |
| TSA (operating at <120°C / 248°F)<br>Thermaline 4700 Aluminum               | 200<br>35/coat (1-2 coats) | Thermal spray aluminum or aluminum alloy<br>Aluminum-silicone |

| RECOMMENDED SYSTEMS (SYSTEM 2B)                                             | DFT (MICRONS)          | PRODUCT DESCRIPTION                                                                                      |
|-----------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------|
| TSZ<br>Carboguard 60 or 60 LH<br>Carbothane 134 HG                          | 200<br>125<br>60       | Thermal spray zinc or zinc alloy<br>Epoxy polyamide<br>Acrylic polyurethane                              |
| TSZ<br>Carboguard E19 Primer<br>Carbomastic 18 FC<br>Carboxane 2000 Topcoat | 100<br>25<br>125<br>75 | Thermal spray zinc or zinc alloy<br>Epoxy polyamide<br>Modified epoxy<br>Siloxane modified multi-polymer |
| TSZ<br>Carboguard 893<br>Carbothane 134 HG                                  | 200<br>125<br>60       | Thermal spray aluminum or aluminum alloy<br>Cycloaliphatic amine epoxy<br>Acrylic polyurethane           |
| TSZ<br>Carboguard E19 Primer<br>Carbomastic 18 FC<br>Carbocrylic 1295 HS    | 100<br>25<br>125<br>75 | Thermal spray zinc or zinc alloy<br>Epoxy polyamide<br>Modified epoxy<br>Reactive acrylic                |



# Coating System No. 3

## (Pre-qualification required for System 3B only)

**Service:** Specific lining services

**Applications:** **System 3A:** Potable water tanks (approved by relevant authorities)  
**System 3B:** Ballast water tanks/Internal seawater filled compartments (IMO PSPC Qualified system is acceptable)  
**System 3C:** Tanks for stabilized crude, diesel, and condensate  
**System 3D:** Process vessels operating <75°C/167°F and <0.3 MPa  
**System 3E:** Process vessels operating <80°C/176°F and <7.0 MPa  
**System 3F:** Process vessels operating <130°C/266°F and <3.0 MPa  
**System 3G:** Vessels for methanol, monoethylglycol, etc.

| SYSTEM NO.                           | RECOMMENDED SYSTEMS                                | DFT (MICRONS) | PRODUCT DESCRIPTION                                      |
|--------------------------------------|----------------------------------------------------|---------------|----------------------------------------------------------|
| <b>System 3A</b>                     | Phenoline Tank Shield                              | 350-500       | Solvent-free epoxy phenalkamine                          |
|                                      | Carboguard 891 VOC<br>Carboguard 891 VOC           | 150<br>150    | Cycloaliphatic amine epoxy<br>Cycloaliphatic amine epoxy |
| <b>System 3B<br/>(Pre-qualified)</b> | Carbomastic 18 FC<br>Carbomastic 18 FC             | 175<br>175    | Modified epoxy<br>Modified epoxy                         |
|                                      | Carboguard 635*<br>Carboguard 635                  | 160<br>160    | Epoxy phenalkamine<br>Epoxy phenalkamine                 |
|                                      | Carboguard 60 LH (C901)*<br>Carboguard 60 LH       | 175<br>175    | Epoxy polyamide<br>Epoxy polyamide                       |
| <b>System 3C</b>                     | Phenoline Tank Shield                              | 350-500       | Solvent-free epoxy                                       |
|                                      | Plasite 4500 FS                                    | 500           | Solvent-free; fast-cure epoxy                            |
|                                      | Phenoline 353 LT<br>Phenoline 353 LT               | 150<br>150    | Epoxy-novolac<br>Epoxy-novolac                           |
| <b>System 3D</b>                     | Phenoline 353 or 353 LT<br>Phenoline 353 or 353 LT | 150<br>150    | Epoxy-novolac<br>Epoxy-novolac                           |
| <b>System 3E</b>                     | Phenoline 1205<br>Phenoline 1205                   | 175<br>175    | Glass-flake epoxy novolac<br>Glass-flake epoxy novolac   |
| <b>System 3F</b>                     | Plasite 4550 Series                                | 500-650       | Solvent-free epoxy novolac                               |
| <b>System 3G</b>                     | Carbozinc 11                                       | 75            | Inorganic ethyl-silicate zinc                            |

\*May be used over preconstruction primer Carboweld 17FG or Carboweld 11.



## Coating System No. 4

### (Pre-qualification required)

**Service:** Non-skid deck system

**Applications:** Walkways

Escape routes

Lay down areas

| SYSTEM TYPE          | PRE-QUALIFIED SYSTEMS                                                              | DFT (MICRONS)                  | PRODUCT DESCRIPTION                                                                                  |
|----------------------|------------------------------------------------------------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------|
|                      | Carbozinc 859<br>Carboguard 890 GF with Filler 47<br>Carbothane 134 HG             | 90<br>300<br>60                | Zinc-rich epoxy<br>Non-skid; glass-flake epoxy<br>Acrylic polyurethane                               |
| Hummervoll System 1: | HI EP Sealer<br>HI EP Deck Coat<br>Quarts Sand<br>HI EP Deck Top Coat              | 150<br>350<br>400<br>700       | Epoxy Sealer<br>High-build epoxy<br>Aggregates<br>High-build epoxy                                   |
| Hummervoll System 2: | HI EP Sealer<br>HI EP Deck Coat<br>Quarts Sand<br>HI EP Deck Top Coat<br>Al. Oksyd | -<br>200<br>800<br>1250<br>750 | Epoxy Sealer<br>High-build epoxy<br>Aggregates<br>High-build epoxy<br>Anti-skid broadcast aggregates |

## Coating System No. 5A

### (Pre-qualification required)

**Service:** Epoxy-based fire protection

**Applications:** As required by end user

| PRE-QUALIFIED SYSTEMS                                       | DFT (MICRONS)            | PRODUCT DESCRIPTION                                               |
|-------------------------------------------------------------|--------------------------|-------------------------------------------------------------------|
| Carbozinc 858<br>Carboguard 60 or E19 Primer<br>Pyroclad X1 | 75<br>35<br>As required  | Zinc-rich epoxy<br>Epoxy polyamide tie-coat<br>Epoxy fireproofing |
| TSA<br>Carboguard 60 or E19 Primer<br>Pyroclad X1           | 200<br>75<br>As required | Thermal spray aluminum/alloy<br>Epoxy tiecoat<br>Fireproofing     |

\*Pre-qualification system was tested without a topcoat over the epoxy fireproofing; however, Carboline recommends one of the topcoat options for exterior offshore use. For more information about the topcoat options please contact your Carboline representative.



# Coating System No. 6A, 6B, & 6C

(Pre-qualification required for 6A & 6B topcoats: must have been pre-qualified under System 1 test)

Applications: System 6A: Un-insulated stainless steel

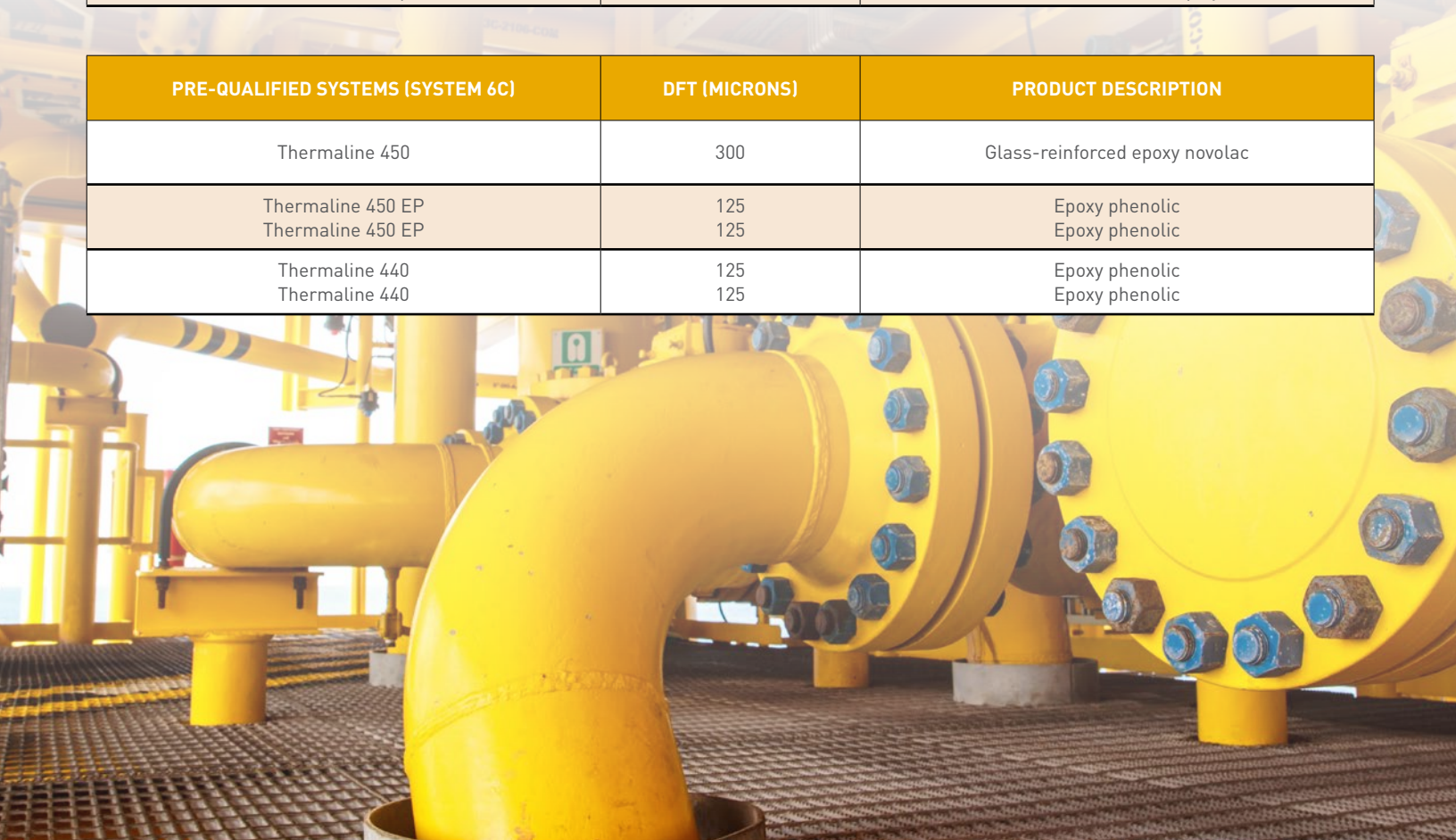
System 6B: Hot dip galvanized steel

System 6C: Insulated stainless steel piping and vessels up to 150°C / 302°F

| PRE-QUALIFIED SYSTEMS (SYSTEM 6A) | DFT (MICRONS) | PRODUCT DESCRIPTION             |
|-----------------------------------|---------------|---------------------------------|
| Carboguard 60                     | 50            | Epoxy polyamide                 |
| Carboguard 60                     | 100           | Epoxy polyamide                 |
| Carbothane 134 HG                 | 75            | Acrylic polyurethane            |
| Carboguard E19 Primer             | 50            | Epoxy polyamide                 |
| Carbomastic 18 FC                 | 100           | Modified epoxy                  |
| Carboxane 2000 Topcoat            | 75            | Siloxane modified multi-polymer |
| Carboguard 893                    | 50            | Cycloaliphatic amine epoxy      |
| Carboguard 893                    | 100           | Cycloaliphatic amine epoxy      |
| Carbothane 134 HG or 134 HP       | 75            | Acrylic polyurethane            |

| PRE-QUALIFIED SYSTEMS (SYSTEM 6B) | DFT (MICRONS) | PRODUCT DESCRIPTION             |
|-----------------------------------|---------------|---------------------------------|
| Carboguard 60                     | 50            | Epoxy polyamide                 |
| Carboguard 60                     | 100           | Epoxy polyamide                 |
| Carbothane 134 HG                 | 75            | Acrylic polyurethane            |
| Carboguard E19 Primer             | 50            | Epoxy polyamide                 |
| Carbomastic 18 FC                 | 100           | Modified epoxy                  |
| Carboxane 2000 Topcoat            | 75            | Siloxane modified multi-polymer |

| PRE-QUALIFIED SYSTEMS (SYSTEM 6C) | DFT (MICRONS) | PRODUCT DESCRIPTION            |
|-----------------------------------|---------------|--------------------------------|
| Thermaline 450                    | 300           | Glass-reinforced epoxy novolac |
| Thermaline 450 EP                 | 125           | Epoxy phenolic                 |
| Thermaline 450 EP                 | 125           | Epoxy phenolic                 |
| Thermaline 440                    | 125           | Epoxy phenolic                 |
| Thermaline 440                    | 125           | Epoxy phenolic                 |



# Coating System No. 7A, 7B, & 7C

## (Pre-qualification required)

**Applications:** System 7A: Carbon and stainless steel in the splash zone

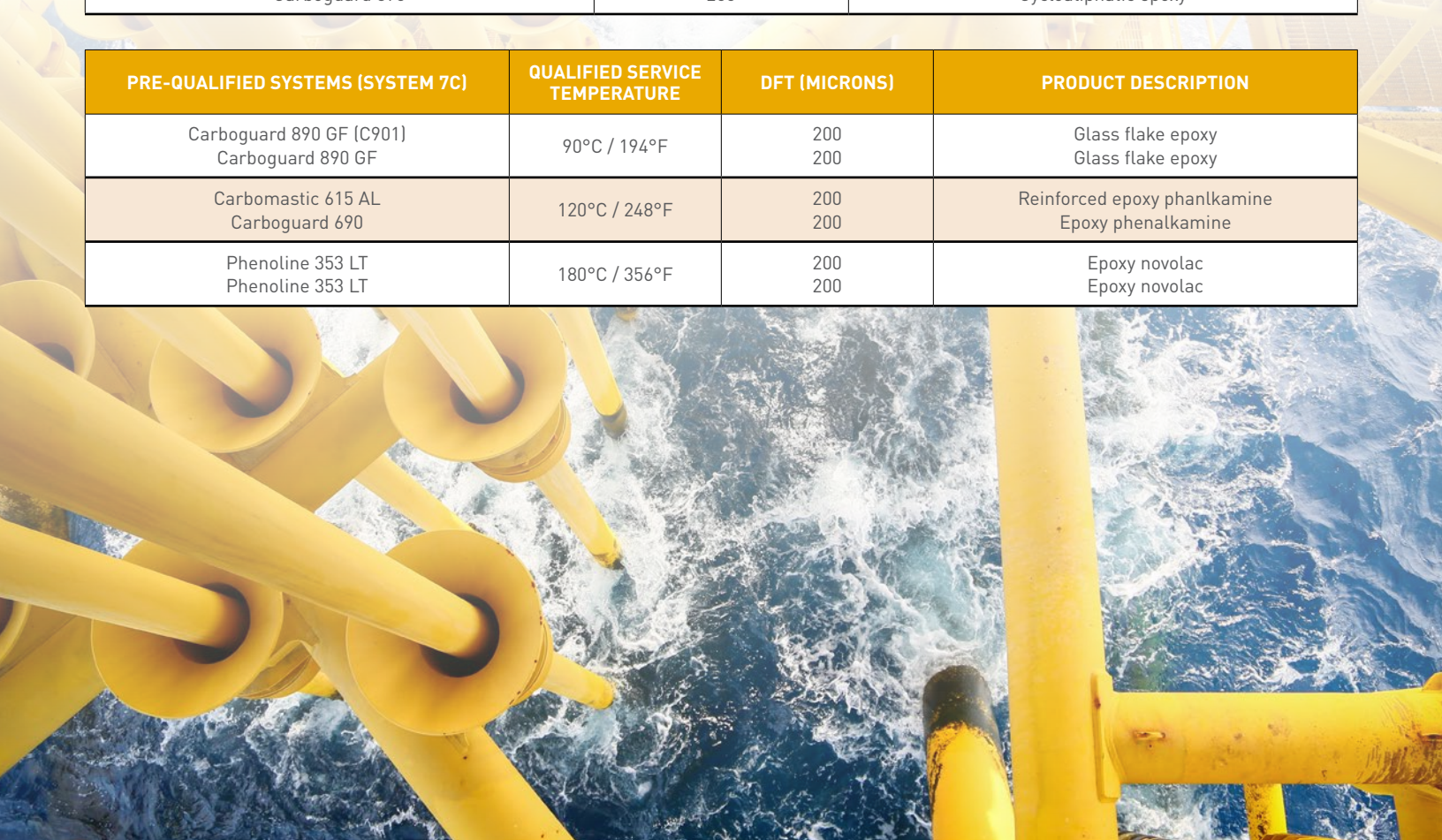
System 7B: Submerged carbon and stainless steel up to 50°C/122°F

System 7C: Submerged carbon and stainless steel greater than 50°C/122°F

| PRE-QUALIFIED SYSTEMS (SYSTEM 7A)      | DFT (MICRONS) | PRODUCT DESCRIPTION                                              |
|----------------------------------------|---------------|------------------------------------------------------------------|
| Carbozinc 859<br>Carboguard 1209       | 100<br>450    | Zinc-rich epoxy<br>High load; glass flake epoxy                  |
| Carboguard 1209<br>Carboguard 1209     | 425<br>425    | High load; glass flake epoxy<br>High load; glass flake epoxy     |
| Carboguard 890 GF<br>Carboguard 890 GF | 225<br>225    | Glass flake epoxy<br>Glass flake epoxy                           |
| Carboglas 1601 SZ<br>Carboglas 1601 SZ | 500<br>500    | Glass flake fumarate polyester<br>Glass flake fumarate polyester |

| PRE-QUALIFIED SYSTEMS (SYSTEM 7B)      | DFT (MICRONS) | PRODUCT DESCRIPTION                                |
|----------------------------------------|---------------|----------------------------------------------------|
| Carboguard 890 GF<br>Carboguard 890 GF | 200<br>200    | Glass flake epoxy<br>Glass flake epoxy             |
| Carbomastic 615 AL<br>Carboguard 690   | 200<br>200    | Reinforced epoxy phanlkamine<br>Epoxy phenalkamine |
| Carboguard 890<br>Carboguard 890       | 200<br>200    | Cycloaliphatic epoxy<br>Cycloaliphatic epoxy       |

| PRE-QUALIFIED SYSTEMS (SYSTEM 7C)             | QUALIFIED SERVICE TEMPERATURE | DFT (MICRONS) | PRODUCT DESCRIPTION                                |
|-----------------------------------------------|-------------------------------|---------------|----------------------------------------------------|
| Carboguard 890 GF (C901)<br>Carboguard 890 GF | 90°C / 194°F                  | 200<br>200    | Glass flake epoxy<br>Glass flake epoxy             |
| Carbomastic 615 AL<br>Carboguard 690          | 120°C / 248°F                 | 200<br>200    | Reinforced epoxy phanlkamine<br>Epoxy phenalkamine |
| Phenoline 353 LT<br>Phenoline 353 LT          | 180°C / 356°F                 | 200<br>200    | Epoxy novolac<br>Epoxy novolac                     |



## Coating System No. 8

**Service:** Structural steel with maximum operating temperatures less than 80°C/176°F

**Applications:** Internal and fully dry and ventilated areas

| PRE-QUALIFIED SYSTEMS                              | DFT (MICRONS) | PRODUCT DESCRIPTION                       |
|----------------------------------------------------|---------------|-------------------------------------------|
| Carbozinc 858<br>Carboguard E19 Primer or Rustbond | 60<br>25      | Zinc-rich epoxy<br>Epoxy polyamide primer |
| Carboguard 60                                      | 150           | Epoxy polyamide                           |
| Carboguard 893                                     | 150           | Cycloaliphatic amine epoxy                |

## Coating System No. 9

**Service:** Steel with maximum operating temperatures less than 150°C

**Applications:** Bulk supplied carbon steel valves

| PRE-QUALIFIED SYSTEMS                  | DFT (MICRONS) | PRODUCT DESCRIPTION              |
|----------------------------------------|---------------|----------------------------------|
| Thermaline 450                         | 300           | Glass-reinforced epoxy novolac   |
| Thermaline 450 EP<br>Thermaline 450 EP | 150<br>150    | Epoxy phenolic<br>Epoxy phenolic |
| Thermaline 440<br>Thermaline 440       | 150<br>150    | Epoxy phenolic<br>Epoxy phenolic |



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