

PART I GENERAL

1.01 SCOPE

- A. This guide details the procedures recommended by the CARBOLINE CO. for the application of Carboguard 891 VOC protective coating system to the interior of process and storage tanks/vessels in which the immersion service has been confirmed by CARBOLINE CO. Contact CARBOLINE CO. Technical Service Department for alternative lining application guide where Carboguard 891 VOC is to be used for potable water or food grade service.
- B. In cases where there is a procedure difference between this guide and any other document or standard referred to, the other guide's author and the CARBOLINE CO. Technical Service Department shall be consulted.
- C. The applicator shall review this guide and consult the CARBOLINE CO. Technical Service Department regarding its interpretation, disapproval or request for procedure changes. Deviations from this guide shall be discussed and agreed to by the CARBOLINE CO. Technical Service Department.
- D. The coating material manufacturer's current product data sheets are to be used in conjunction with and become a part of this guide. The applicator should adhere to all accommodations of product shelf life, mixing ratios and acceptable thinners.
- E. The applicator shall use industry standard inspection equipment, quality control and inspection policies in regards to the application of this product.
- F. It is the responsibility of the applicator to adhere to industry standard application and inspection procedures for record keeping purposes.
- G. The coating system is to be applied in a minimum of two separate, spray-applied coats using contrasting colors to a nominal film thickness range as specified (or recommended) for the intended service. The typical service would require a nominal 16 mils total system DFT. The acceptable total system minimum is 14 mils DFT and the maximum is 18 mils DFT. Reference the current version of SSPC-PA 2 standard for film thickness conformance.
- H. It is the applicator's responsibility to compute and supply adequate ventilation to prevent explosion and toxicity hazard conditions as prescribed by standards of

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good safety practices, local and state regulations, OSHA and other federal regulations.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data, installation instructions, and chemical resistance data for the lining. Include certification indicating compliance of materials with requirements.

PART II PRODUCTS

2.01 COATING MATERIALS

- A. Lining material shall be Carboguard 891 VOC consisting of two coats. Reference: CARBOLINE CO. Product Data Sheet Carboguard 891 VOC.

2.02 COLOR

- A. Lt. Gray (N700), White (N800), & Blue (N100)

PART III EXECUTION

3.01 PRELIMINARY INSPECTION

Before any coating is begun, the interior surfaces of the vessel shall be inspected to see that the following has been done.

- A. All weld splatter, sharp projections, slivers and pits shall be removed.
 - 1. Weld metal shall be used to fill repairs. Putty shall not be used without consulting the CARBOLINE CO. Technical Service Department.
- B. Welds that are rough, irregular and not well formed shall be corrected by grinding smooth.
- C. All sharp corners and edges shall be rounded to at least a 1/8" radius.
- D. No other conditions exist which would shorten the expected life of the applied coatings.
- E. Used vessels. (Based on the previous service environment, decontamination may be required.)

1. Decontamination shall be performed by one or a combination of the following methods.
 - (a) Prebaking at 400°F or a minimum of 50°F above maximum service temperature for 4 hours.
 - (b) Steaming for 24 hours with 15 psi steam.
 - (c) Ultra high pressure (30,000 psi) washing.
 - (d) High pressure washing with cleaning or neutralizing chemicals.
2. Decontamination shall be verified by the use of a chloride test kit, pH test or black light, whatever is dictated by the previous service conditions.

3.02 SURFACE PREPARATION

- A. Oil and grease shall be removed from the surfaces to be coated with a suitable safety solvent prior to abrasive blasting.
 1. Vessel design and fabrication details shall be in accordance with NACE SP0178. All sharp edges and welds shall be ground smooth to a rounded contour in accordance with NACE Weld Preparation Designation "D" and all weld splatter shall be removed prior to abrasive blasting.
 2. Non-carbon steel parts that will not be coated shall be removed and/or protected prior to blasting, including but not limited to hatch covers, hatch rings, outlet valves and vents. The lining shall be terminated on the non-carbon steel approximately 1" past the interface.
 3. The compressed air used for blasting should be free of water and oil. To determine cleanliness, blast without abrasive into a white cloth. The trap and separators shall be blown down until subsequent cloth tests show no oil or water contamination.
 4. All weld seams shall be individually blasted prior to blasting other areas of the vessel. Weld seams are the areas of early coating failure. Removal of contaminants and achieving the proper anchor pattern in the heat affected zone at the welds is critical to the service life of the lining.
- B. Surfaces shall be blasted to a "Near White metal" in accordance with SSPC-SP 10/NACE No. 2 Joint Surface Preparation Standard.

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1. The anchor pattern or "tooth" in the metal shall be a minimum of 2 mils with an average representing 20 to 25% of the total dry film thickness of the coating system. Proper abrasive shall be a sharp natural abrasive, slag grit or steel grit similar to or equal to G40 or other abrasives having a sharp, hard-cutting surface, properly graded, dry, of best quality and of proper size to produce the specified anchor pattern.
- C. All internal surfaces shall be vacuum cleaned to remove all blast media and dust after blasting is completed. External surfaces may be air blown clean using dry, oil-free air.
1. No visible oxidation shall be permitted between the time of blasting and priming the blasted surface.
 2. The interior of the vessel shall be protected from moisture from the time of blasting to the time application and curing are completed.

3.03 COATING APPLICATION

- A. Before starting coating application, it is recommended that the applicator read all available safety data including, but not limited to, OSHA approved material safety data sheet, product data sheet and backup label.
- B. Carboguard 891 VOC consists of two parts which must be separately pre-mixed prior to using. After combining and power mixing the two parts of the coating, it **must** be allowed to stand approximately 15 minutes. After the components have been combined and power mixed, the coating has a pot life of 2 hours at 60°F and 1.25 hours (75 minutes) at 75°F. A decrease in film builds and spray properties will be noted at the end of the usable pot life. Reference: The CARBOLINE CO. product data sheet Carboguard 891 VOC.
1. It will always be necessary to thin the coating. Normal application temperatures will require thinning addition starting at approximately 10-12% by volume with either of Thinner #225E, #2, or #76 (**Note: Potable water linings ONLY allow for Thinner 225E and a maximum of 10% thinning**). Above the normal application temperature range of 65-85°F (18-29°C) will require additional thinning at the rate of approximately 5% per 5°F (3°C) of increased temperature. Thinning shall proceed only after 15-minute induction period has been allowed.
- C. The lining application must not proceed until the substrate temperature is a minimum of 5°F above the dew point. Minimum air or surface temperature at the time of application should be 50°F.

- D. The weld seams shall be scrub striped before spray application begins.
1. The striping shall be performed with a good quality bristle brush using Carboguard 891 VOC which has been thinned equal parts by volume with Thinner #225E, 2, or 76 (Only 225E allowed for potable water applications).
 2. Scrub striping is accomplished by moving the brush back and forth in a scrubbing motion to work the primer into crevices and undercut areas of the welds.
 3. Bristles left on the surface shall be removed before the coating dries.
- E. All areas subject to overspray and drips (such as the vessel bottom) shall be protected by a suitable covering while spraying other areas in the vessel.
- F. Conventional Air Spray: Use a dual-regulated conventional air spray pressure pot equipped with lid-mounted agitator. Hose assembly shall be minimum $\frac{3}{8}$ " (9.5 mm) I.D. nylon fluid hose and minimum $\frac{5}{16}$ " (8.0 mm) I.D. atomization air hose at a maximum 50 feet (15 m) long. Use an industrial-grade conventional air spray gun such as BINKS® Model 2100™ or 2001™ gun, DeVilbiss® JGA-510 or MBC-510 gun (or equal) with minimum 0.070" (1.8 mm) I.D. fluid tip and appropriate air cap. Set the pot pressure to 10-15 psi (0.6-1.0 bar) and the atomization air pressure to approximately 40-50 psi (2.4-3.5 bar).
- Airless Spray: Single airless spray pump shall be 30:1 or greater with a minimum fluid output rate of 2.5 gallons/minute (9.4 liters/minute) or greater such as GRACO® King, Premier, Xtreme® NXT or Xtreme® XL, WIWA® Professional or Herkules, BINKS® MX Series airless pump or equal with 30-mesh fluid filter. Airless fluid hose shall be minimum 5000 psi (345 bar) rated and minimum $\frac{3}{8}$ " (9.5 mm) I.D. by 25-100 feet (7.6-30.5 mm) long or a minimum $\frac{1}{2}$ " (12.7 mm) I.D. by 100+ feet (30.5+ mm) long with a short $\frac{3}{8}$ " (9.5 mm) I.D. by 3-foot (0.9 m) long whip hose at the spray gun. Airless spray gun shall be rated to minimum 5000 psi (345 bar) such as GRACO® XTR-7, Flex Plus, or Silver Plus, WIWA® 500 F, BINKS® Airless 75M or Airless 1M gun (or equal) with 0.017-0.021" (0.43-0.53 mm) reversible airless spray tip. The recommended fluid spray pressure range is 1500-2300 psi (103-159 bars). Adjust spray tip orifice size and fluid spray pressure to obtain a spray pattern with the best possible atomization.
- G. Air supply shall be uncontaminated.
- H. Apply a mist bonding pass. Allow to dry approximately one minute but not long enough to allow film to dry completely.

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- I. Apply a crisscross multi-pass moving gun at a fairly rapid rate maintaining a wet appearing film. By allowing the solvents to flash off for a few minutes, additional fast multi-passes may be applied until you have a film thickness of approximately 5 to 7 wet mils (measured on a wet film thickness gauge) and approximately 4 to 6 mils dry film.
- J. Venting from the bottom of the vessel is recommended during the application and initial curing process.
- K. Overcoat time will vary with the temperature and ventilation and will require 10 to 12 hours at 75°F for enclosed spaces with additional time allowed to gain “walk-on” firmness at tank or vessel bottom surfaces.
 1. Force curing may be used between coats for time and work planning. Following the circulation of fresh air at 70 to 100°F through the vessel for a period of 2 to 5 hours, the substrate temperature shall be increased at a maximum rate of 30°F per 30 minutes until the substrate reaches a temperature of 125°F for a period of one hour. Do not exceed 150°F substrate temperature at any location on the interior.
- L. Prior to applying Carboguard 891 VOC topcoat, all runs, drips and rough areas should be removed from the prime coat by light sanding and recoating.

NOTE: Be sure to remove any and all dust and debris from sanding before applying topcoat.
- M. Topcoat - By repeating Steps H and I, using Carboguard 891 VOC, a homogenous film of 8 to 12 mils is obtained.
 1. Topcoat shall be smooth in appearance (ie. free of visual defects) and the system holiday-free as determined using low voltage wet sponge holiday tester.
- N. Defects shall be sanded smooth and recoated for retest for film thickness and holidays.
- O. Repeat steps H and I as desired for a third coat application, not to exceed 20 mils, DFT.

3.04 CURING

- A. Normally, polymerization and curing will take place in 14 days at 50°F (10°C), 7 days at 75°F (24°C), or 5 days at 90°F (32°C). If temperature is below 50°F/10°C, force curing is recommended.

- B. Curing must be complete before the vessel is closed up or subjected to weather conditions below the 50°F minimum curing requirements (time and temperature). This may require force curing.
- C. Force curing at elevated temperatures does increase resistance to certain exposures; therefore, when exposure is severe, force curing is recommended to obtain maximum resistance.
- D. An air dry time of 2 to 5 hours at 70 to 100°F with forced ventilation shall be allowed before force curing. After air dry period, substrate temperature shall be raised approximately 30°F in increments of 30 minutes until the desired temperature is reached. Curing time begins when the specific substrate temperature is reached.

SUBSTRATE TEMPERATURE		CURING TIME	SUBSTRATE TEMPERATURE		CURING TIME
°F	°C		°F	°C	
130	54.4	18 Hours	170	76.6	3 ½ Hours
140	60.0	10 Hours	180	82.2	2 ½ Hours
150	65.5	6 Hours	190	87.7	2 Hours
160	71.1	4 ½ Hours	200	93.3	1¾ Hours

3.05 INSPECTION

- A. Dry film thickness shall be determined utilizing electronic Type 2 non-destructive dry film thickness gages which have been properly adjusted per manufacturer's directions in accordance with ASTM D7091 or the examples in SSPC-PA 2 Appendix 8. Conformance to recommended dry film thickness shall be verified in accordance with SSPC-PA 2. The total dry film thickness shall be a minimum of 8 mils (or as specified, which takes precedence), with a maximum total system thickness of 20 mils DFT.
- B. After minimum 24 hours curing at 70-100°F (21-38°C), the coating film can be tested for discontinuities using low voltage wet sponge holiday detector such as Tinker Razor Model M1 (or equal) in accordance with NACE SP0188 Standard Practice. All discontinuities shall be repaired and spot retested.

3.06 REPAIR

- A. All repairs shall be made prior to force curing or before maximum immersion lining recoat time of 30 days at 60°F (16°C), 14 days at 75°F (24°C), or 7 days at 90°F (32°C) has elapsed since final coat application. All locations to be repaired

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or touched up shall be pre-cleaned in accordance with SSPC-SP 1 to remove all contaminants prior to any surface preparation.

B. For repair of holidays and lightly damaged locations in the lining where steel substrate is not exposed or revealed, prepare the surface of the Carboguard 891 VOC finish coat by lightly sanding making sure to feather transition any divots or abrupt edges in the coating, and also abrade/roughen adjacent surface of the finish coat at least 1-2 inches (2.5-5.0 cm) where repair coating will overlap. Remove all dust and debris and then mix and apply Carboguard 891 VOC in accordance with the Product Data Sheet instructions to repair/touch up locations. Do **not** overlap onto any unprepared surfaces. Repair areas which are greater than 1.0 ft² (0.09 m²) each in size shall be repair coated by spray application. Verify dry film thickness at all locations complies with specified dry film thickness range.

C. Inadequate or excessive DFT

1. Inadequate DFT locations shall have additional material applied by either spray or brush depending on size of area. If the Carboguard 891 VOC finish coat has not been allowed to cure more than 130 days at 60°F (16°C), 14 days at 75°F (24°C), or 7 days at 90°F (32°C), then the coating surface need only be clean, dry and sound at time of additional Carboguard 891 VOC application to obtain specified dry film thickness range. If the maximum recoat time above has been exceeded, then the surface of 891 VOC finish coat at low dry film thickness locations must be abraded/roughened by either hand or power sanding with coarse grit media or by abrasive sweep blasting, remove all dust and debris, and then spot apply properly mixed Carboguard 891 VOC only to prepared locations; do **not** overlap onto any unprepared surfaces. Verify dry film thickness at all locations complies with specified dry film thickness range.

2. Excessive DFT locations of Carboguard 891 VOC lining shall be hand and/or power sanded using coarse grit media if total DFT does not exceed 20 mils (500 microns) DFT; if greater than this, the topcoat shall be removed by abrasive blasting to reveal prime coat surface. Remove all dust & debris and check remaining dry film thickness using properly adjusted Type 2 electronic DFT gage. If prime coat thickness is within acceptable range, then apply spot repair finish coat of properly mixed Carboguard 891 VOC not to exceed 10 mils (250 microns) DFT. Do **not** overlap onto any unprepared surfaces. Repair areas which are greater than 1.0 ft² (0.09 m²) each in size shall be repair coated by spray application. Verify

dry film thickness at all locations complies with specified dry film thickness range.

- D. Major and Minor damage or defect repair locations which expose steel substrate or require defective coating removal down to the steel substrate shall be pre-cleaned in accordance with SSPC-SP 1 to remove all contaminants prior to performing any surface preparation.
1. Major repair locations shall be prepared by abrasive blast cleaning "Near White Metal" in accordance with SSPC-SP10/NACE No. 2 Joint Surface Preparation Standard to provide a dense, angular surface profile at a minimum of 2.0 mils (50 microns) with feathering transition of all coating edges back to tightly adherent coating in addition to abrading surrounding, adjacent coating surfaces 8-12 inches (20-30 cm) back from leading edges where repair coating applications will overlap. Remove all dust and debris from prepared locations.
 2. Major damage or defect repair locations where abrasive blasting is not permitted as well as Minor damage or defect repair locations shall be prepared by Power Tool Cleaning to Bare Metal in accordance with SSPC-SP11 with the creation of a dense and angular surface profile at minimum of 2.0 mils (50 microns) through proper use of Monti Tools MBX® Bristle Blaster using coarse steel belts. All coating edges shall be feather edge transitioned back to tightly adherent coating and the surrounding, adjacent coating surfaces 8-12 inches (20-30 cm) back from the leading edges (where repair coating applications will overlap) shall be abraded/roughened to exhibit a dense, consistent surface profile by hand and/or power sanding using coarse grit media as per the methods described in SSPC-SP2/SSPC-SP3. Remove all dust and debris from prepared locations.
 3. Apply repair coats of Carboguard 891 VOC to prepared locations in accordance with Section 3.03 of this document. Apply coating with brush, roller or spray gun depending on the size of the area to be patched. The number of coats required may vary depending on the size of the area to be repaired and the method of application. Verify dry film thickness at all locations complies with specified dry film thickness range.
- E. Refer to Section 3.04 for curing information and Section 3.05 for inspection information.

3.07 SAFETY CONSIDERATIONS

- A. THE SOLVENT IN THIS COATING IS FLAMMABLE AND CARE AS DEMANDED BY GOOD PAINTING PRACTICE, OSHA, STATE AND LOCAL SAFETY CODES, ETC., MUST BE FOLLOWED CLOSELY. Keep material away from excessive heat, direct sunlight, sparks and open flame and use necessary safety equipment, such as respiratory, eye and skin protection, explosion-proof

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electrical equipment, non-sparking tools and ladders, etc. Avoid contact with skin and breathing of vapor or spray mist. When working in tanks, rooms and other enclosed spaces, adequate ventilation with fresh air changes must be provided in accordance with OSHA standards. Refer to the Carboline Company Bulletin PA-3 as well as the Carboline Product Data Sheet and Safety Data Sheets for additional information.