

PROCEDURAL GUIDE

FOR APPLICATION OF

ARC COMPOSITES FOR METAL

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1.0 GENERAL SCOPE

This specification defines the technical and quality requirements for the application of ARC Composites to metal substrates. The application of the ARC Composite products shall only occur on properly prepared metallic surfaces as defined by the technical requirements herein; otherwise premature failure is likely to occur.

2.0 REFERENCE CODES AND STANDARDS

The following documents are part of this procedural specification and are referred to by title or basic designation only. The documents are applicable to the extent indicated by the specific reference.

2.1 SSPC- THE SOCIETY FOR PROTECTIVE COATINGS

- A. SSPC-SP 1 "Solvent Cleaning"
- B. SSPC-SP 2 "Hand Tool Cleaning"
- C. SSPC-SP 3 "Power Tool Cleaning"
- D. SSPC-SP 5 "White Metal Blast Cleaning"
- E. SSPC-SP 7 "Brush Off Blast Cleaning"
- F. SSPC-SP 10 "Near White Metal Blast Cleaning"
- G. SSPC-SP 11 "Power Tool Cleaning to Bare Metal"
- H. SSPC-VIS 1 "Visual Standard for Abrasive Blast Cleaned Steel"
- I. SSPC-PA 1 "Shop, Field, and Maintenance Painting"
- J. SSPC-PA 2 "Measurement of Dry Paint Thickness with Magnetic Gauges"
- K. SSPC-PA 3 "A Guide to Safety in Paint Application"
- L. SSPC AB 1 "Mineral and Slag Abrasives"

2.2 NACE INTERNATIONAL- THE CORROSION SOCIETY

- A. TPC Publication No. 2 "Coatings and Linings for Immersion Service"
- B. NACE Publication 6G186 "Surface Preparation of Contaminated Steel Surfaces."
- C. NACE RP 0178 "Fabrication Details, Surface Finish Requirements and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service"
- D. NACE RP 0287 "Field Measurement of Surface Profile of Abrasive Blast Cleaned Surfaces Using Replica Tape"
- E. NACE RP 0188 "Discontinuity (Holiday) Testing of Protective Coatings"
- F. NACE RP 0288 "Inspection of Linings on Steel and Concrete"

2.3 ASTM INTERNATIONAL

- A. ASTM D 4285 "Method for Indicating Oil or Moisture in Compressed Air"
- B. ASTM E 337 "Test Method for Measuring Relative Humidity with Sling Psychrometer"
- C. ASTM D 1186 "Method for Nondestructive Measurement of Dry Film Thickness of Non-magnetic Coatings Applied to Ferrous Base"
- D. ASTM F 22 "Test Method for Hydrophobic Surface Films by Water-Break Test"
- E. ASTM D 4262 "Test Method for Chemical Cleaned or Etched Concrete Surfaces"

2.4 INTERNATIONAL STANDARDS ORGANIZATION (ISO)

- A. ISO 8501-1 "Preparation of Steel Substrates Before Application of Paints and Related Products"
- B. ISO 8501-1 Sa 3 "Blast-Cleaning to Visually Clean Steel"
- C. ISO 8501-1 Sa 2½ "Very Thorough Blast-Cleaning"
- D. ISO 8501-1 Sa 1 "Light Blast-Cleaning"
- E. ISO 8501- St "Power Tool Cleaning"

3.0 WORK SITE SAFETY

- 3.1 All work practices shall be in compliance with site specific requirements for safe work practices and environmental guidelines in accordance with the local jurisdiction. Work site safety is the responsibility of the CONTRACTOR and the OWNER.
- 3.2 ARC Composites contain compounds that are considered hazardous by nature. Refer to the appropriate ARC Material Safety Data Sheet (MSDS) for product hazards and personal protective equipment minimum requirements.
- 3.3 The use of flammable, hazardous solvents for cleaning of tools and equipment may be required in accordance with the ARC Product Data Sheets. When flammable, hazardous solvents are used, proper fire protection equipment is required. In addition, all personnel hazard precautions and personnel protective requirements as listed on the solvent manufacturers MSDS must be followed.

4.0 MATERIAL CONTROL/DISPOSAL

This section describes the proper storage of ARC materials required for an application and the proper disposal of waste generated.

- 4.1 During all phases of work, adequate protective coverings and enclosures shall be provided as required by site specific requirements in accordance with the local jurisdiction, to limit unrestricted release of cleaning compounds, blast residues, and overspray. Monitoring of environmental discharges shall be performed, as required.
- 4.2 The shelf stability of ARC Composites is dependent on storage temperatures. All materials shall be properly stored to avoid damage due to conditions outside those specified on the applicable ARC Product Data Sheet.

- 4.3 Prior to application all ARC Composites shall have their lot numbers recorded on an ARC Lining Inspection Log. Materials, which have exceeded, or will exceed, their shelf life before being applied shall not be used.
- 4.4 A current MSDS or suitable safety sheet for all ARC materials and cleaning products shall be on site.
- 4.5 Substitute materials may be approved only by the OWNER and with the approval of the MANUFACTURER.
- 4.6 Waste including, but not limited to, abrasive blast residues, old coatings, surface contaminants, cleaning chemicals, disposable application supplies, and unused product shall be disposed of in accordance with site specific environmental guidelines.

5.0 ENVIRONMENTAL CONDITIONS AND CONTROLS

During the phases of surface preparation, application and curing, environmental conditions will require careful monitoring and may require supplemental controls. Critical areas of concern are relative humidity, dew point and surface temperature of the substrate. ARC Lining Inspection Logs shall be maintained recording these conditions periodically throughout the application period.

- 5.1 All environmental test inspection equipment shall be verified to be in sound working order and calibrated. The operator shall have sufficient knowledge to operate the test equipment.
- 5.2 Test readings shall be taken 1/2 hour before the beginning of each shift at the work area. Readings shall be taken regularly every four hours unless changing weather conditions require more frequent checks.
- 5.3 At no time during abrasive blasting or coating shall the surface temperature be less than 3°C (5°F) above the dew point. Dehumidification equipment should be used if it is anticipated that the dew point could drop below the minimum value.
- 5.4 Under specific conditions (high humidity and low temperatures), a phenomena known as amine blush can form on the surface of epoxy-based coatings during curing. This “blush” can impair intercoat adhesion. For urethane-based coatings it can cause bubbles and swelling. The maximum relative humidity that can be tolerated during coating phases of epoxy-based products is as specified in the following chart:

<u>Surface Temperature</u>	<u>Relative Humidity</u>
16-20°C (60-69°F)	<55%
21-25°C (70-77°F)	<70%
26-31°C (78-89°F)	<75%
32-38°C (90-100°F)	<80%

- 5.5 Urethane-based coatings should not be applied if the relative humidity is 80% or above as it can cause bubbles and swelling.

6.0 SURFACE PREPARATION

All surfaces are to be prepared with the intent of providing a substrate that is structurally sound, clean of visible/ invisible contaminants, and roughened to the degree specified.

- 6.1 A pre-inspection of surface conditions is required to establish the optimum manner and sequence of the surface preparation to follow. This pre-inspection should be recorded on the applicable section of the ARC Lining Inspection Log.

NACE RP 0178 "Fabrication Details, Surface Finish Requirements and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service" is the standard for identifying the quality of welds, angle braces, joints, connections and structural members. Either SSPC-VIS 1 "Visual Standard for Abrasive Blast Cleaned Steel" or ISO 8501-1 "Preparation of Steel Substrates Before Application of Paints and Related Products" shall be used to identify the initial rust grade.

6.2 Structural Integrity

- 6.2.1 Structural integrity of components shall be inspected. Untreated skip or spot welds are not permissible. Butt-welding is preferred over lap welding or riveted connections.

- 6.2.2 Sharp edges and fillets should be ground to a minimum radius of 3 mm (1/8"). Fillets and corners must be accessible for grinding and application.

- 6.2.3 All weld spatter shall be removed.

6.3 Chemical Decontamination

- 6.3.1 Surfaces shall be inspected for chemical contamination, as this will impair adhesion. Inspection for chemical contaminants should be performed prior to final abrasive blasting. Suitable cleaning procedures shall be instituted to remove contaminants to the acceptance criteria level.

- 6.3.2 The removal of salt contamination from the metal substrate before final surface preparation and application of ARC composites is critical in preventing osmotic blistering. The presence of water soluble contaminants, in particular chlorides and sulfates, shall be verified by equipment in accordance with NACE Technical Publication 6G186 "Surface Preparation of Contaminated Steel Surfaces". Repeated high pressure fresh water flushes (210-560 bar/3,000-8,000 psi) or steam cleaning followed by drying cycles are recommended to remove these contaminants. The contaminant level shall not exceed 10 $\mu\text{g}/\text{cm}^2$ for sulfates and 5 $\mu\text{g}/\text{cm}^2$ for chlorides.

- 6.3.3 The presence of hydrocarbon based contaminants shall be verified by equipment in accordance with ASTM F 22 "Test Method for Hydrophobic Surface Films by Water-Break Test" and/or by ultraviolet light. Below each method is briefly described.

- 6.3.3.1 Water –Break Test: The water break-test is used to detect insoluble contaminants on surface of the substrate.

Procedure

- 1) Spray a mist of atomized distilled water onto the surface to be tested.
- 2) Observe the reaction of the water on the surface.
 - If the water gathers in lenses that last about 25 seconds before wetting out the surface, the surface is clean.
 - If the water forms droplets on the surface within 25 seconds, the surface is likely to be contaminated.

6.3.3.2 Ultraviolet light: Greases and oils will usually fluoresce when exposed to ultraviolet light, however some synthetic oils will not. Fluorescence cannot normally be detected in sunlight, therefore a hood of black cloth may be used to shield the sun. This test may have varying results and many materials such as lint will fluoresce.

Procedure

- 1) Shine a low or high frequency ultraviolet light source over the surface. Observe the surface for fluorescence. Wear appropriate UV protective glasses, as recommended by the light manufacture.
 - A bright yellow or lime green fluorescence indicates oil or grease contamination.
 - An absence of fluorescence indicates that the surface is not likely contaminated by oil or grease.

6.3.3.3 These contaminants must be removed by flushing the surface with high pH water based emulsifying cleaner and fresh water flushes. Final steam cleaning is required. After cleaning, the surface shall be re-inspected per the above sections.

6.3.4 The presence of microbiological induced corrosion (MIC) shall be verified via suitable means. If MIC exists the OWNER and CONTRACTOR will develop a suitable cleaning system by consulting a MIC specialist. Removal usually entails mechanical cleaning of any slime layer, sedimentation and corrosion products followed by a biocidal treatment specific to the microbiological contaminants found.

6.3.5 The pH of the surface to be lined shall be verified to be no more than one point below or two points above neutral rinse water (normal pH 6-9). Follow ASTM D 4262 "Test Method for Chemically Cleaned or Etched Concrete" modified for steel surfaces.

6.4 Surface finish

6.4.1 Surface finish and cleanliness shall be inspected and graded according to the requirements of SSPC-VIS 1 or ISO 8501.

6.4.2 The surfaces shall be cleaned of all loose contaminants. Loose surface contaminants may be removed by wire brush, wheel or sweep blasting per SSPC-SP2, SSPC-SP3, SSPC-SP7, or ISO 8501-St. Hard deposits may be chipped off with suitable tools. Positive control of debris is required to prohibit re-deposition of contaminants.

6.4.3 The abrasive selected shall meet the requirements of SSPC-AB1 "Mineral and Slag Abrasives", or equal, and be capable of generating a level of cleanliness in compliance with SSPC-SP5/ ISO Sa3 "White Metal" with a rough, angular profile between 75-125 μm (3-5 mils) unless otherwise stated on the ARC Product Data Sheet. Measurement of blast profile shall be in compliance with NACE RP 0287 "Field Measurement of Surface Profile of Abrasive Cleaned Surfaces Using Replica Tape".

6.4.4 When abrasive blasting high hardness metal alloys, such as heat treated steels, and austenitic stainless steels, which toughen by work hardening, the use of ceramic media will be required in order to achieve the specified 75-125 μm (3-5 mils) rough, angular profile.

- 6.4.5 Compressed air shall be moisture and oil free. Cleanliness shall be tested at the beginning of each shift for each compressor system in operation. Direct the compressed air onto a clean white piece of blotter paper held approximately 0,5 m (18") from the air outlet. After a minimum of two minutes, inspect the paper for signs of moisture or oil contamination. If present, take corrective steps to eliminate the problem (e.g. clean, replace, or add additional moisture and oil traps, clean lines, etc.).
- 6.4.6 Spent abrasive and blast dust should be positively contained and not allowed contaminate the site.
- 6.4.7 Power tool cleaning per SSPC-SP11 "Power Tool Cleaning to Bare Metal" should be performed only where required in inaccessible areas and small localized spots. The acceptable profile range in these select areas is 50-75 μm (2-3 mils). These areas shall be mutually agreed upon by the CONTRACTOR and the OWNER and documented on an attachment to the ARC Lining Inspection Log.
- 6.4.8 The prepared surface shall be blown down with clean, dry compressed air or vacuumed as required to remove dust residues immediately prior to applying the first ARC product. Localized repair areas may be cleaned with ARC 204 or other non-flammable solvent, which leaves minimal residue.
- 6.4.9 The resulting surface shall comply with a cleanliness rating as stated in SSPC-SP5, ISO 8501-1 Sa 3 (White Metal) with a rough, angular profile of between 75-125 μm (3-5 mils). In field applications and if permitted by the applicable ARC Product Data Sheet, SSPC-SP10/ ISO Sa 2 ½ "Near White Metal" cleanliness is permissible.

HOLD POINT - Inspection of Surface for Acceptance to Coat

The following tests and acceptance criteria must be met before allowing application to proceed and shall be documented on an ARC Lining Inspection Log.

<u>Test</u>	<u>Method</u>	<u>Specified Limits</u>
Profile Measurement	NACE RP 0287	75-125 μm (3-5 mils) with a rough, angular profile. (unless otherwise specified by the product data sheet)
Relative Humidity (RH)	ASTM E 337	Refer to Sec. 5.4
Dew Point (DP)	NA	Surface temperature $>3^{\circ}\text{C}$ (5°F) above DP per Sec. 5.3
Surface Cleanliness	SSPC-VIS 1 ISO 8501-1	SSPC SP 5 ISO Sa 3 (SSPC-SP10/ ISO Sa2½ acceptable in field applications per Sec. 6.4.9)
pH	ASTM D 4262	6-9 (assuming a pH 7 rinse water)
Oil/ Grease Contamination	ASTM F 22	No visible water beading or UV light indication.
Chloride Contamination		$\leq 5 \mu\text{g}/\text{cm}^2$
Sulfate Contamination		$\leq 10 \mu\text{g}/\text{cm}^2$

7.0 DOCUMENTATION

In order to provide traceability and QC controls, the following items shall be recorded and maintained by the CONTRACTOR on the ARC Lining Inspection Log:

- Lot numbers of all ARC Composites.
- Environmental conditions during preparation, application, and curing of composites.
- Q.C. recording of surface cleanliness, profiles, contamination levels, etc.

8.0 MIXING & APPLICATION

In order to control quality, all work shall be accomplished by properly trained and qualified individuals. Familiarity with high performance protective coating application is required in the areas of equipment maintenance and operation, safety, surface preparation, coating application methods, and inspection.

- 8.1 ARC composite materials may contain hazardous vapors. Sufficient ventilation must be furnished to maintain vapor concentrations well below the applicable health and safety limits established in the material safety data sheets and by local jurisdiction requirements.
- 8.2 Material shall be mixed on a clean, dry, non-porous surface or container with a clean, stiff mixing stick. Mix product until uniform in color and no streaks remain. If mixing in a pail use a variable speed power mixer with a non-air-entraining blade, such as a "Jiffy" blade, and operate at slow speed. Periodically scrape the mixing blade and the sides of container.
- 8.3 Do not exceed the Working Time as defined in the Product Data Sheet. Larger masses or warmer application temperatures reduce effective working times and may necessitate the use of smaller batches. If the material begins to tear or drag during application, then the product's working time has been exceeded.
- 8.4 Prior to applying a lining product, all pitting, erosion damage, internal corners, skip welds, rough/porous welds, undercuts, gouges or other surface discontinuities shall be filled in or transitioned to a smooth radius with a suitable ARC repair compound. Before application, equipments structural integrity shall first be verified with the OWNER.
- 8.5 If grinding edges, corners, and welds to a 3 mm (1/4") smooth radius is impractical, stripe coat these surfaces with a suitable ARC product with a brush prior to applying the first lining coat.
- 8.6 Multiple coat applications of ARC composite coatings are possible without additional surface preparation provided the subsequent coat is applied before the earlier coat has achieved the "Overcoat End" stage of cure, as defined on the Product Data Sheet. If this stage is exceeded the material must be allowed to reach "Full Load" cure. Then roughen the surface with power tools, sanding, or by light abrasive sweep blasting per SSPC-SP7 / ISO 8501-1 Sa 1 "Brush Off Blast Cleaning". Vacuum and solvent rinse to remove all dust residues before applying subsequent coats.

- 8.7 Cleanliness Between Coats - If dust or debris is present on the surface of the coating, remove it by brushing, dry wiping, blowing down with clean, dry compressed air, or vacuuming. Remove spots of grease or oil by solvent cleaning. If blast products or debris are present, remove them by scraping or light sanding prior to application of the next coat. If the removal exposes bare metal in the affected areas, spot repair prior to application of the finish coat.
- 8.8 Each product has a recommended minimum, nominal and maximum total dry film thickness per coat as indicated on each product data sheet. The final acceptable film thickness range will be verified in accordance with SSPC-PA 2." Measurement of Dry Paint Thickness with Magnetic Gauges"
- 8.9 If amine blush occurs prior to applying the final coat, it must be removed. Material must be allowed to reach "Full Load" stage. Then roughen the surface with power tools, sanding, or by light abrasive sweep blasting per SSPC-SP7 / ISO 8501-1 Sa 1 "Brush Off Blast Cleaning". Vacuum and solvent rinse to remove all dust residues before applying subsequent coats.

9.0 FINAL INSPECTION

Once the desired film thickness has been applied and allowed to cure to "Light Load" stage final quality control inspection can be performed. This phase of the work is intended to measure and record the film quality, total dry film thickness, and film integrity.

- 9.1 Areas where film discrepancies are noted such as, but not limited to, drips, runs, sags or over application shall be ground down to comply with the maximum recommended film thickness. These repairs will be recorded on the applicable section of the ARC Lining Inspection Log.
- 9.2 Film thickness measurements shall be taken in compliance with SSPC-PA2. In no case will the average of the readings deviate beyond the minimum and maximum allowed film thickness per SSPC-PA2 without the OWNER's approval. This will be documented on the ARC Lining Inspection Log.
- 9.3 The finished lining shall be free of flaws or film breaks as indicated by NACE RP0188. Areas where reduced thickness is noted such as, but not limited to, sharp edges, weld seams, or under application shall be lightly abraded by power tool or sweep blasting, solvent wiped and re-coated to the specified minimum film thickness. These repairs will be recorded on the applicable section of the ARC Lining Inspection Log.
- 9.4 The finished lining shall be free of flaws or film breaks as indicated by NACE RP0188. Holiday Testing per NACE RP0188 may be performed on certain ARC composites in accordance with ARC Technical Bulletin 004 after the coating has cured to "Full Load" stage. Where holidays are detected, these will be marked with chalk or a marking pen. Do not use grease pencil. Record results on schematic map. Repairs shall be performed per Section 10.0.

10.0 REPAIRS AND REMEDIAL WORK

Localized damage to the coated surfaces caused during installation or service may occasionally need repair. Periodic inspection of all coated surfaces should be scheduled to comply with established maintenance schedules. Areas requiring repairs shall be documented by the OWNER.

A schedule of repairs shall be developed to meet the minimum standards of workmanship outlined in this specification.

10.1 General Repair Procedure

- 10.1.1 The repair area will have all the poorly adhered coating material removed.
- 10.1.2 The perimeter of the area exhibiting coating material with satisfactory adhesion will be tapered and roughened using power tools or sandpaper.
- 10.1.3 The exposed metal substrate will be chemically decontaminated as required and the surface will be re-prepared in accordance with Section 6.0
- 10.1.4 The repair coating will be applied to extend from the metal substrate up onto the tapered transition of the existing coating for each coat applied for the repair.
- 10.1.5 The repair coating(s) will be applied in accordance with the applicable product data sheet.