



# General Application Procedures for Rubber Linings on storage vessels

## INDEX

<i>Section</i>	<i>Page</i>
1 GENERAL	3
2 SURFACE PREPARATION	3
<b>ABRASIVE BLAST CLEANING</b>	3
3 ADHESIVE SYSTEM APPLICATION	4
4 APPLICATION OF RUBBER LINING	5
5 CURING	6
6 INSPECTION AFTER CURE	7
7 REPAIRS TO LINING	7

## 1 GENERAL

- 1.1. This specification covers the procedures necessary to assure that all materials, equipment and operations are in conformance with RubberSource and industry standards.
- 1.2. Hold points may include (but are not limited to):
  - 1.2.1 Pre-surface preparation
  - 1.2.2 Ambient conditions/compressed air cleanliness
  - 1.2.3 Immediately following surface preparation
  - 1.2.4 Adhesion test panels
  - 1.2.5 Prior to each cement layer application
  - 1.2.6 Following each material layer
  - 1.2.7 Spark testing
  - 1.2.8 Cure testing
  - 1.2.9 Repairs
- 1.3. SSPC refers to specifications and published information of the "Steel Structures Painting Council", 4400 Fifth Avenue, Pittsburgh, PA 15113, USA.
- 1.4. NACE refers to publications of the "National Association of Corrosion Engineers", P.O. Box 218340, Houston, TX 77218, USA.
- 1.5. ASTM refers to standards of the "American Society for Testing of Materials", 1916 Race Street, Philadelphia, PA 19103, USA.
- 1.6. RMA refers to technical bulletins of the "Rubber Manufacturers Association", 1400 K Street N.W., Washington, D.C. 20005 USA.

## 2 SURFACE PREPARATION

- 2.1. Surfaces shall be inspected prior to the start of surface preparation to assure that they are dry, and that visible deposits of oil and grease have been removed by "Solvent Cleaning" (SSPC-SP1). In addition, the inspector shall identify surface imperfections (such as weld spatter, porosity, pits, laminations, slivers or crevices) for repair as appropriate. (Ref. RMA Bulletins 1, 2, 3. / NACE SP0298-2007 6.3).
- 2.2. Ambient conditions shall be checked before and during operations which will expose bare steel (e.g. abrasive blasting, power tools) to determine the air and surface temperatures, relative humidity and dew point temperature. These operations shall not be permitted when the surface temperature is less than 5 degrees F. above the dew point, the relative humidity is over 80% and the temperature is not in the range of 50°F (10°C) to 90°F (32°C).

### ABRASIVE BLAST CLEANING

- 2.3. The compressed air supply for abrasive blasting shall be inspected before and during operations for the presence of oil and/or water by means of the white blotter test. The test shall be performed downstream of separators. The blotter shall be free of visible contaminants of oil or water after being held in the airstream at a distance of 18" (457mm) to 24" (610mm) inches from the source for at least two minutes. (Ref. SSPC Painting Manual Vol. 1 Good Painting Practice, Chapter Six, Section VI.A. "Air Compressor and Air Cleanliness".) Air pressure at the nozzle shall be determined using a hypodermic needle pressure gauge according to the procedure outlined in SSPC-Vol. I Good Painting Practice.



- 2.4. Chapter VI.E "Blast Cleaning Nozzles and Nozzle Pressure." A hypodermic needle gauge indicates the pressure at the nozzle, the end of the system.
- 2.5. Abrasive shall be inspected to assure that it is clean, dry and the type size capable of producing the desired surface profile. Reference data for determination of the adequacy of abrasive type and size can be found in NACE Publication 6G164 and SSPC-SP COM "Surface Preparation Commentary" Sections 5 and 6 which state the type, grade, and surface condition of the steel to be cleaned, type of blast cleaning system employed the finished surface to be produced.
- 2.6. On stainless steel components, special care must be taken to assure that a profile of 2.0 mils (0.05mm) minimum is achieved.
- 2.7. Strict adherence to air temperature, 50°F (10°C) to 90°F (32°C), relative humidity and shell temperature 5°F (2.8°C) above the dew point will be required. At the beginning and middle of every shift, the inspector will record in the area of the tank they will be working, the steel temperature, the air temperature, and calculate the dew point and relative humidity.
- 2.8. The entire surface of the tank to be lined is to be white metal blasted clean (SSPC-SP-5) to a profile of 2.0 mils (0.051 mm) minimum. This will be tested and recorded by the contractor using a Testex Press 0 film blast profile gauge (Testex, Inc.) or other suitable method. Applicator shall supply testing materials as specified and make them available for additional inspection.
- 2.9. All areas blasted are to be primed with one coat of primer as soon as possible after blasting. Allow to dry one- hour minimum and preferably 24 hours. If the primer is left sitting for 7 days and greater it will require an additional coat before the application of the intermediate. Apply primer and intermediate adhesive to surfaces with temperatures less than 38°C.
- 2.10. All sandblasted areas are to be vacuumed and wiped to "white glove" clean to remove all contaminating materials prior to applying primers.
- 2.11. A test panel must be made prior to the start of production blasting to establish the proper grade of blast media to be used to achieve the required blast profile. The test and panel must be reviewed and approved. Test panel shall be supplied by the lining applicator.
- 2.12. Upon commencement of sandblasting and continuing for the remainder of the project; no gasoline, kerosene or diesel operated engines will be permitted in or near the tank without venting such equipment to the exterior atmosphere.

### 3 Adhesive System Application

- 3.1. Strict adherence to environmental conditions as in is required for all stages of adhesive application. Avoid drips and runs in primers, intermediates, and tack as they can be detrimental to the adhesion.

Relative Humidity	Maximum Wait
Over 80%	No Application
70-80%	1 Hour
60-69%	4 Hours
50-59%	8 Hours
Below 49%	24 Hours

- 3.2. Vacuum primer as in if dust has accumulated on its' surface. Apply one coat of intermediate over the primer that was applied to hold the blast. Allow to dry one hour.
- 3.3. Apply one coat Tack over the intermediate at least on the same day as the intermediate has been applied. Allow to dry at least one half-hour.
- 3.4. Just prior to the application of the rubber repeat above step (3.3) using Tack on substrate then apply Tack on rubber lining. Allow to dry until tacky on both the substrate and the rubber – approximate 1 hour. Note, before applying adhesive to the lining, the rubber may require to be freshened" by giving it a wipe with solvent.
  - One coat of Primer, Chemlok 205/289 on metal only
  - One coat of adhesive, Chemlok 6224/290 on metal only
  - Two coats of tack cement, Chemlok 286 on metal & surrounding 4" (100mm) of parent lining

#### 4 APPLICATION OF RUBBER LINING

- 4.1. Strict adherence to environmental conditions as in is required for all stages of lining application.
- 4.2. All layout marks on rubber must be made using chalk or spotted chalk lines. Use of a metal scribe or other device that cuts or scratches the rubber is not permitted.
- 4.3. Rubber is to be cut using skiving machines with blade set for a 30 degree skive cut. Reservoir of water must be kept full during cutting. Rough, wavy, irregular surface of skive cuts will be rejected. All mill edges and mills end shall be cut off by liner. A skiving knife is also acceptable to use.
- 4.4. Prior to application, rubber is to be protected from dust, grease and oil while lying on the cutting tables by covering with polyethylene sheets. All cutting tables must be smooth and flat and not leave joint impressions on the rubber.
- 4.5. Depending on the rubber lining the rubber may be required to sit on hot tables (minimum of 10 minutes / 100°F guideline) before application to facilitate workability. General guideline is when the rubber is warm to the back of the hand.
- 4.6. All panel seams are to be 30 degrees closed reversed skives with a two (2) inch minimum (50mm) overlap. All lining personnel must be certified trained to applicate linings and have knowledge with skive joint requirements. All seams, and any rubber to rubber adhesion should be done just simply wiping both surfaces with solvent, wait for the solvent to evaporate and become tacky. Then proceed to stitch.
- 4.7. Panels of rubber lining shall overlap each other a minimum of two (2) inches (50mm). Use an open-skive on the underneath edge as a closed-skive on the overlapping edge. Panel size should not be greater than 10 linear feet.
- 4.8. The sheet lining shall be rolled and stitched as required to exclude all air between the lining and substrate. Trapped air may be vented with a needle, but the vent opening must be covered with a suitable overlay. To do this properly, the needle must be inserted at a 30° angle, and wiped with toluene after withdrawing the needle. Review repair procedures.
- 4.9. The sheet lining shall extend over the entire outside of flanges. Special conditions such as internal steam curing may be an exception.

- 4.10. The ambient temperature during lining application shall be maintained between 50°F (10°C) and 120°F (51°C) and the relative humidity shall not exceed 80%, 50 % is the optimum humidity level for adhesion. The temperature of the surface being cemented shall be at least 5°F (2.8°C) above the dew point or wet bulb temperature.
- 4.11. All deficiencies and defects found must be removed and relined prior to cure.
- 4.12. During the installation of the floor lining, all contractors' personnel must wear nail-less soft rubber sole shoes, rubber shoe covers, or work in stocking feet.
- 4.13. All joints and seams will be staggered. No four-corner joints will be permitted. The rubber lining panels on the floor, wall, etc. shall be applied in a manner that will assure complete and uniform adhesion with the steel. There shall be no air trapped behind the lining. There shall be no stretching of the rubber during application. All rubber is to be supported so as not to be stretched during application. The lining shall be free of blisters, porosity, and tears. After installation and before cure, the lining is to be spark tested at 15,000 volts (15kv) and visually inspected for trapped air, loose edges, and damage to the rubber linings.

## 5 CURING

- 5.1. The following instrumentation shall be installed to monitor temperatures:
  - 5.1.1 Internal temperature measuring devices
  - 5.1.2 Internal temperature recorder
  - 5.1.3 Outside steel temperature measuring devices
  - 5.1.4 Outside steel temperature recorder
- 5.2. The rubber lining shall be cured by vulcanizer, internal pressure or by atmospheric steam as per the time and temperatures listed on the Material Specification Sheet.
- 5.3. Sufficient steam and the necessary steam headers are to be used to provide for a complete cure of the vessel.
- 5.4. It is recommended that a multi-point temperature recording device be used to monitor the cure at several external and internal points.
- 5.5. Introduction of steam (Atmospheric Cure) should be over a period of four to six hours rise from start to the desired maximum temperature of 212°F (100°C). Direct impingement of steam onto the rubber lining should be avoided. Time of cure starts counting when outside steel temperature reaches 68-71°C.
- 5.6. It is very important that a method be provided for draining the condensate from the tank during the curing process.
- 5.7. If a pressure cure is used it is extremely important to cool down under air pressure. If this is not done, the lining can blister and crack.
- 5.8. Internal temperature and outside surface metal temperature shall be monitored and charted throughout the entire cure cycle on an hourly basis. Atmospheric cures must be allowed to cool to ambient temperature.
- 5.9. Line blind flanges or metal plate and cure for ASTM Adhesion Testing.



## 6 INSPECTION AFTER CURE

- 6.1. After cure, all surfaces are to be thoroughly inspected to the same criteria as the pre-cure inspection. Blisters (trapped air), loose laps, etc., are to be marked in chalk and numbered for future repairs.
- 6.2. All surfaces are to be spark tested (RMA Bulletin 13).
  - 6.2.1 This spark test and all others shall be the same using Electro-Technic model BD-10AV or BD-50EV model testers operated at 15,000 volts (15kv).
  - 6.2.2 All personnel spark testing shall carry a second spark tester because spark testers are subject to failure from overheating.
  - 6.2.3 All testers are to be operated 15 minutes, and then turned off for 15 minutes. Testers must be allowed to cool down to avoid burnout.
- 6.3. All scaffolding or other equipment will have pneumatic tires and will be rolled on  $\frac{3}{4}$ " (18mm) plywood, with rounded corners, at all times.
- 6.4. A durometer (Shore "A" as per ASTM Standards) hardness survey shall be made of the cured lining. A sufficient number of readings shall be taken at all elevations to assure all areas of the lining are properly cured. The lining shall be allowed to cool to ambient temperature before durometer readings are taken.
- 6.5. Monitor adhesion testing (per ASTM D429) on blind flange assembly that contractor has previously lined, installed and cured. The rubber shall be adhered to the steel so that tests will show strength of adhesion not less than 25 pounds (11.3 kilos) as determined by the standard test in accordance with ASTM D429.
- 6.6. All pinholes indicated by breakthroughs when spark testing shall be repaired. The repair materials, application methods, and curing procedures shall be based upon the type, size and frequency of the defect. Patching with materials other than those recommended by RubberSource is not permitted.

## 7 REPAIRS TO LINING

- 7.1. Bubbles or Blisters:
  - 7.1.1 All lining material containing bubbles or blisters (air trapped between rubber & steel substrate) shall be removed to an area of good adhesion.
  - 7.1.2 Bevel edges of remaining rubber to approximately 45-degree angle to the metal and buff existing rubber back at least 4" (100mm) from the edge of area to be repaired.
  - 7.1.3 Repairs are to be made with the same rubber as the parent lining material.
- 7.2. All exposed steel surfaces shall be prepared by blasting or grinding to a clean bright metal finish.
- 7.3. Upon completion of surface preparation, adhesives shall be prepared and applied as follows:
  - Primer on metal only
  - Intermediate on metal only
  - Tack on metal & surrounding 4" (100mm) of
  - Parent lining (follow section 3)

7.4. Upon completion of adhesives system application, rubber will be applied as follows:

- 7.4.1 To repair cracks and small areas, fill in the area flush with existing lining using uncured filler stock. Cover this with larger patch extending out 4" (100mm) on the existing lining, using the specified material. Activate the backside with solvent as well as the top of the inlay piece.
- 7.4.2 For large areas (above 12" (300mm) diameter or equivalent) to be covered, it will be satisfactory to use a single thickness of the repair stock over the metal area. Bringing stock up over an extended bevel in the existing lining and back 4" (100mm) on the original rubber. Activate the backside side with solvent before applying.
- 7.4.3 Should air be inadvertently trapped during these procedures, puncture blisters with a hypodermic needle and stitch down the stock. The air will bleed out through the needle. Important: insert needle on a 30° angle, remove needle, wipe the area with toluene and stitch the needle hole closed. Apply a 2" (50mm) square patch of uncured rubber centered over point of needle insertion.
- 7.4.4 Completed repair shall be re-spark tested at 15,000 volts (15kv) in accordance with established procedures.
- 7.4.5 Area of repair shall then be re-cured in accordance with manufacturers' material specification sheet.
- 7.4.6 Repaired areas will be re-checked in accordance with the spark tests.
- 7.4.7 Loose seam edges and skives must be corrected.
- 7.4.8 Loose seam edges and skives shall be repaired by grinding feather edging loose area, if it is possible to maintain a minimum seam overlap of 2" (50mm) upon completion of the repair.
- 7.4.9 If 2" (50mm) minimum overlap cannot be maintained, an area of 4" (100mm) back from defect on all sides shall be buffed to a rough grainy surface.
- 7.4.10 Adhesives system shall be applied in accordance with application of adhesives in this procedure.
- 7.4.11 Upon completing application of adhesive, an overlay will be applied to the cemented area, skives down and stitched in place.
- 7.4.12 Testing prior to curing will be in accordance with spark test procedures outlined in this procedure.
- 7.4.13 Curing will be in accordance with curing procedures outlined in this procedure.
- 7.4.14 Testing after curing will be in accordance with testing procedures as outlined in this procedure.
- 7.4.15 Third Party Rubber Inspector is to sign off to verify all procedures have been followed and documented.

\*\*\*Note: The above procedures is based as a guideline, please refer to the NACE Standard Practice / Sheet Rubber Linings for Abrasion and Corrosion Services (SP0298-2007) for in-depth procedures and methods.