# Down-Tube End Coating Specification
# Rev. 10-21-01

## DESCRIPTION OF WORK

The ARCOR® down-tube end coating system is currently a 8-10 mil system applied at 6- 8" down the tube tied in with a 30-40 mils Tubesheet coating system. The milage is achieved with 2-3 coats. Appropriate surface preparation will be completed prior to coating application and environmental controls will be maintained in accordance with ARCOR®s' Application Specifications.

Based on information from visual inspection and the Tubesheet layout drawings, ascertain the Tubesheet size and the tube I.D. ranges for the purpose of supplying proper size tube rollers & flap wheels and to get an accurate material calculation and abrasive needs.

Calculated total surface area of each tubesheet (includes tube openings).

Calculated total internal surface area to be coated down each tube.

Calculate the Waterbox to Tubesheet joint as number of linear feet.

Determine size and location of manway access points. These manways will serve as ingress and egress for personnel and equipment.

Determine accessible locations for equipment as needed including dust collection, dehumidification, blast, compressor, sprayer, pressure wash.

Determine needs for electrical hookups for equipment such as dust collection, dehumidifier, sprayer, lighting.

Determine needs for air hookups for equipment such as air tool manifold.

Determine needs for scaffolding inside waterboxes to easily reach all areas of Tubesheet.

## APPROACH TO WORK

ARCOR® can provide all material, technical support, supervision, equipment and labor to install the down-tube protective coating system.

ARCOR® proposes to coat the tubesheets and waterboxes using the **S-30™ Prime / EE-11** coating system; a 100% solids, multifunctional Novolac epoxy system designed specifically as a protective coating for metals in aggressive service/cooling water environments, particularly in tubesheet environments where a flexible, resilient coating is required to resist the long term effects of metal flex, expansion, contraction and high temperature gradients between the hot & cold sides.

ARCOR® **S-30 Prime**™ will be used as the prime coat. In addition to being a Novolac epoxy, the S-30 Prime™ contains Zinc Phosphate, which inhibits corrosion and effectively eliminates undercutting. (Data Sheet and MSDS on ARCOR® CD-ROM).

ARCOR® **EE-11** will be used as the build & topcoat. EE-11 was designed with the use of reactive plastisizers. This gives EE-11 flexibility and resiliency while maintaining its chemical & temperature resistance (up to 265°F Immersion, pH 1.0-13.5). This resiliency & flexibility is crucial in resisting the effects of flexural & thermal stresses of condenser tubesheets, particularly at the critical tube/tubesheet joint. (Data Sheet and MSDS on ARCOR® CD-ROM).

Both the S-30 Prime™ and EE-11 products can be roller and/or spray applied greatly reducing application time.

ARCOR® Test Data (found on the ARCOR® CD-ROM) includes a copy of a Lehigh University study (1992 & 1993 & summary condensed version) of Atlas Cell coating disbondment resistance commissioned by Pennsylvania Power & Light, Northeast Utilities and Baltimore Gas & Electric. Seven of the most widely used commercial protective coatings were tested in thin film and thick film variations. **ARCOR â 's S-30Ô Prime** system tested highest in all categories.

1. **Down-Tube Coating System (8 +/- 2 mils):**

ARCOR® recommends application of a three-coat **ARCOR â S-30Ô /EE-11** system, for a final dry film thickness of 6-10 mils. The coating shall cover 6" down each tube-end (specific conditions may vary the total length of the tube coating such as level of wear, presence of tube insert, customer specification etc.).

**Surface Preparation:**

The tubes are prepared for coating in as follows with certain steps dependant on whether there is an existing coating present down-tube.

1. All tube ends should be trimmed to flush with Tubesheet. This done for two reasons;
    a. it will allow for a more complete cleaning of corrosion at the tube/Tubesheet joint and prevent 'shadowing' during blast ;
    b. it will allow a smoother more complete tie-in of the Tubesheet and down-tube coating; peaks and edges are weak points in any coating system.

   A tube ID cutter is used, no lubricant required. The mandrel and blades are sized for the specific tube OD/ID and depth of cut so it is important to obtain accurate information. Do not rely on specifications and drawings. Measure yourself.

   The tube/Tubesheet joint is the most critical area, the most prone to failure, so it is extremely important that the area be as clean and profiled as possible.

2. Debur tubes as needed and repair any damaged ends. Use medium grit flapper wheels and abrasive grinding cones attached to an air drill attached via a custom mandrel allowing extension down a full 12" of the tube. The goal is to get a uniform smooth clean surface free of major surface defects that can hinder the coating process.

3. Existing coating is removed by a 10-12,000 PSI Hydro Laser, down the entire tube length, with a 360° tip. This will remove 90% of the existing tube coating with the added benefit of cleaning the entire tube length. If there is a concern of high chloride levels and the potential for chloride contamination, Chlor*Rid® should be added to the water. This will neutralize chlorides. If working with a new or newly re-tubed unit use a degreaser in first wash.

4. Coating remaining in the tube ends (difficult to get with hydro lance process) is cleaned with handguns using a more concentrated tip. This will remove all remaining material in the tubes. Any residual at the tube/tubesheet interface will be cleaned during the Blast of the tubesheets.

5. All water in the tubes will then be sucked out using a Vac truck with a 6" hose. Air horns are then installed to facilitate full drying over a 48-hour period.

6. The tubes are profiled using abrasive blasting. After the sheets are cleaned each tube is profiled using a lance. Use fine-medium grit Black Beauty to attain a 1-2 mil profile.

The lance is a 12” (longer if coating over 10” down-tube) 3/8” stainless steel tube welded to an adapter to allow it to be attached to the end of the blast hose.

The lance is to be inserted to within 2” of the end of the tube coating i.e. 4” if coating 6”. The lance method will result in an approximate 30-40° blast pattern. Inserting within 2” will allow the blast to pattern to reach the final 2” and minimize disturbance of the tube beyond the area to be coated. Mark the lance with a brite colored tape at the insertion depth so the blaster can readily see haw far to insert.

The blaster inserts the lance to the tape mark then pulls the trigger and removes the lance at an even speed. The blaster should count, ‘1001, 1002, 1003’ and be out. Test blast 10 tubes with this count then stop and inspect. Check for even look to profile and color over length of area to coat. Check profile with Testex tape. Adjust count up or down depending on results i.e. longer count if profile is <1 mil and color is uneven, shorter if profile is >2mil. Do another 10 tube test and review. Continue until satisfied with consistent results.

7. The tubes are then blown down with compressed air. They are then checked for cleanliness and touched up with an Acetone soaked roller. This will insure there is no residue in the tube, which could inhibit proper adhesion.

**Down-Tube Coating:**

1. A Prime coat of the S-30 Prime™ will be roller-applied at a thickness of 2-3 mils to a depth of 6.0” The depth is controlled via a locking guide, which slides on the end of the custom made mandrel. The roller will stop when the guide hits the tube end. The rollers are a lint-free tube roller with a ½” nap.

2. An Intermediate coat of EE-11 will be roller-applied at a thickness of 2-3 mils to a depth of 5.5”. The depth is reduced from the Prime coat to allow for a tapering of the coating as it terminates within the tube. The locking guide is moved down the mandrel so the roller will stop when the guide hits the tube end.

3. A Topcoat of EE-11 will be roller-applied at a thickness of 2-3 mils to a depth of 11.0”. The depth is reduced from the Intermediate coat to allow for a tapering of the coating as it terminates within the tube. The locking guide is moved down the mandrel so the roller will stop when the guide hits the tube end.

4. At the completion of the tubesheet coating, the tube ends are then inspected for runs and or puddling on the bottom of the tube, as well as any ‘donut’ rings around the tube end. All defects are addressed with ‘flapper’ wheels and cone grinders to touch-up and smooth out the tube coating. If necessary additional coating should be applied.

5. The amount of material required to coat tubes @ 10 mils is calculated as follows:

   1604/10 mils = 160.4 square feet per gallon,

   160.4 x (1.0 - .30) = 160.4 x .7 = 112.3 sf/gal with 30% waste. Waste in down-tube coating is considerably higher than in general coating.

**2. Tubesheet Coating System (30+/- 5 mils):**

ARCOR® proposes to apply a three (3) coat ARCOR **â S-30 Prime/EE-11Ô** system, for a final dry film thickness of 45 mils. The coating shall cover the entire Tubesheet.

1. The Tubesheets will be Hydro Lased at 35-40,000 PSI to remove all existing coating and fully clean the surface. This step is recommended if an existing cladding system is present i.e. 100+ mils, or if the existing coating is very well adhered. The Hydro Laser removes coating quickly and without resulting large quantities of waste abrasive. If there is a concern of high chloride levels and the potential for chloride contamination, Chlor*Rid® should be added to the water. This will neutralize chlorides. If working with a new or newly re-tubed unit use a degreaser in first wash.

2. Each Tubesheet is the abrasive blasted with 1243 medium grit Black Beauty (Coal Slag) to profile the tubesheet face at 3+ mils.

3. A prime coat of the S-30 Prime™ will be roller-applied at a thickness of 15 mils. This coat is applied during the Primer down-tube coat. Coating down the tubes results in a significant quantity of material getting onto the Tubesheet. This excess is spread by roller and squeegee as the down-tube process progresses. After all tubes in a sheet are done a final light coat of S-30 Prime is rolled over the entire face to smooth it out.

4. A second coat of EE-11 @ 15 mils is applied. This again is done during application of the intermediate down-tube coat.

5. A third coat of EE-11 @ 15 mils is applied. This again is done during application of the final down-tube coat.

6. After the down-tube coating is completed additional milage can be added to the Tubesheets as needed per specification. For best results the EE-11 can be spray applied. Plural spray application allows a smooth coat to be applied with minimal effect to the tube coating. Although EE-11 can be spray applied at 80 mils, the milage should be kept to 20-25 mils per coat to minimize any puddling and/or donut in the tube.

7. After allowing the coating to cure a minimum of 24 hours it is the inspected for defects and/or voids. The multi- coat process will minimize any potential voids. If any are found they are touched up with EE-11. This is done after the tubes are inspected and cleaned of any residual coating.

8. If there is significant tube end sanding/grinding, an additional mist coat of EE-11 should be spray applied at 10 mils. This will give a final smooth gloss finish to the entire sheet and tube ends.

9. The amount of material required to coat a Tubesheet @ 45 mils is calculated as follows:

   1604/45mils = 35.6 square feet per gallon

   35.6 x (1.0 - .20) = 35.6 x .8 = 28.5 sf/gal with 20% waste

## 3. Waterbox to Tubesheet Joint Sealing:

The Waterbox to Tubesheet joint is sealed using ARCOR® ARCTHANE™, a 100% solids high elongation, elastomeric hybridized epoxy/urethane joint sealer that combines the wear resistance of epoxy with the flexibility of urethane. This material can be applied at up to 500 mils per coat without slump.

1. **ARCTHANE**Ô will be applied with a caulk tube and gun in two, 500 mil coats for a final dry film thickness of 1000 mils and a width of 1 inch. Estimate 16 linear feet per gallon with a 25% waste factor.

2. The specification for Application of this joint is provided on the enclosed ARCOR® CD-ROM under 'Specifications'

**4. Quality Control:**

1. Quality Assurance should be maintained throughout the project. The ARCOR® CD-ROM contains copies of all necessary QC forms and checklists.
2. ARCOR® can provide all the necessary inspection equipment and reference materials to verify compliance with the requirements for surface cleanliness, surface profile, abrasive cleanliness, air supply cleanliness, environmental conditions, surface temperatures, wet film thickness, dry film thickness and coating continuity.
3. Maintain a material log which will include material name, kit size, batch number, date of manufacture and shelf life.
4. Refer to ARCOR®'s General Application Specification. This document contains detailed surface preparation and application information along with quality control holds points
5. Refer to ARCOR®'s Spray Application Procedure for details of spray application procedure.
6. Supply dehumidification, heating and dust control equipment for use in establishing and maintaining proper environmental controls. Temperature and humidity conditions must be established and controlled as appropriate in accordance with the material technical specifications.

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