**TECHNICAL REQUIREMENTS AND SPECIFICATIONS**

**FOR THE CORROSION PROTECTION AND/OR REHABILITATION**

**OF STORM WATER CONCRETE/MASONRY LARGE DIAMETER PIPELINE AND STRUCTURES**

**FOREWORD**

This specification covers work, materials and equipment required for protecting and/or restoring concrete structures by monolithic spray-application of a solvent-free, high-build epoxy coating to eliminate infiltration / exfiltration, provide corrosion protection, repair damaged surfaces and enhance structural integrity. Procedures for surface preparation, cleaning, application and testing are described.

1. **GENERAL**
   1. SUMMARY
      1. Solvent-free epoxy coating to be applied to specified surfaces and conforms to the requirements set forth below.
      2. This specification covers all labor, materials, equipment, and services necessary to complete the installation of corrosion protection for concrete and masonry structures as herein specified.
      3. Related Sections: Concrete Repair, Environmental, Health and Safety
   2. REFERENCES
      1. ACI – The published standards of the American Concrete Institute, Farmington Hills, MI.
         1. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
      2. ASTM - The published standards and testing methods of the American Society for Testing and Materials, West Conshohocken, PA.
         1. ASTM C109 - Compressive Strength Hydraulic Cement Mortars
         2. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars
         3. ASTM D543 - Resistance of Plastics to Chemical Reagents
         4. ASTM D638 - Tensile Properties of Plastics
         5. ASTM D695 - Compressive Properties of Rigid Plastics
         6. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics
         7. ASTM D2584 - Volatile Matter Content
         8. ASTM D4258 - Standard Practice for Surface Cleaning Concrete
         9. ASTM D4259 - Standard Practice for Abrading Concrete
         10. ASTM D4787 Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates
         11. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester
         12. ASTM D7234 - Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
      3. ICRI – The published standards of the International Concrete Repair Institute, Des Plaines, IL.
         1. ICRI Technical Guideline No. 03732 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
      4. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
         1. NACE RPO 188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
      5. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
         1. SSPC-SP 1 - Solvent Cleaning
         2. SSPC-SP 5 - White Metal Blast Cleaning
         3. SSPC-SP 10 - Near White Metal Blast Cleaning
         4. SSPC-SP 12 Surface Preparation and Cleaning of Metals by Water jetting prior to Recoating.
         5. SSPC SP-13/NACE No. 6 – Surface Preparation of Concrete.
         6. SSPC-PA 9 - Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages.
   3. SUBMITTALS
      * 1. Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
        2. Material Safety Data Sheets (MSDS) for each product used.
        3. Project specific guidelines and recommendations.
        4. Applicator Qualifications:
           1. Manufacturer certification that the Applicator has been trained in the handling, mixing and application of the products to be used.
           2. Certification that the equipment to be used for applying the products has been approved by the protective coating manufacturer and Applicator personnel have been trained and certified for proper use of the equipment..
           3. Written document providing three (3) years experience and five (5) recent references of Applicator indicating successful application of a 100% solids high-build solvent-free coating by spray application.
           4. Applicator must provide written documentation of having installed a minimum of 50,000 sf of plural component spray applied epoxy coating the same or similar to that specified within the last two (2) years.
           5. Proof of any necessary federal, state or local permits or licenses necessary for the project.
        5. Documentation of requirements of Section 1.6 B & C.
   4. QUALITY ASSURANCE
      1. Coating and repair product(s) shall be capable of being installed and curing properly within the specified environment(s); specifically within environmental conditions of a typical sanitary sewer. Coating product(s) shall be resistant to all forms of chemical or bacteriological attack found storm water systems.
      2. Coating and Repair product(s) shall be fully compatible; including ability to bond effectively (as tested for in Section 3.5 C.) to each other and/or the host substrate, forming a composite system.
      3. Contractor shall utilize equipment for the application of the coating and repair product(s) which has been approved by the product manufacturer; and Contractor shall have received training on the operation and maintenance of said equipment from the product manufacturer. Written certification of such approval(s) and training shall be submitted by the coating and repair product manufacturer(s).
      4. Contractor and contractor personnel shall be certified by, or have their training approved and certified by, the coating and repair product(s) manufacturer(s) for the handling, mixing, application and inspection of the product(s) to be used as specified herein. Written certification of such training shall be submitted by the coating and repair product manufacturer(s) and shall include the individual contractor personnel to be employed on the project.
      5. Inspectors shall be trained in the use of testing or inspection instrumentation and knowledgeable of the proper use, preparation and installation of the product(s) to be used as specified herein.
      6. Contractor shall initiate and enforce quality control procedures consistent with the coating product(s) manufacturer recommendations and applicable NACE, SSPC, ICRI or other standards as referenced herein.
      7. Pre-construction meeting shall take place no less than two weeks prior to Contractor mobilization. All parties to have physical presence on the project during construction shall be present. At this meeting responsibilities and authorities during construction shall be discerned; comments and questions regarding materials and execution of these specifications shall be presented and addressed.
   5. DELIVERY, STORAGE, AND HANDLING
      1. Materials are to be kept dry, protected from weather, and stored under cover.
      2. Coating and repair materials are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat, or strong oxidants.
      3. All materials are to be handled according to their material safety data sheets.
   6. SITE CONDITIONS
      1. Contractor shall conform to all local, state, and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
      2. Confined space entry program and other required safety training certifications shall be submitted by Contractor to Owner as necessary to perform the specified work.
      3. Flow diversion and/or bypass plans shall be submitted by Contractor to Owner as necessary to perform the specified work.
   7. WARRANTY
      1. Contractor shall warrant all work against defects in materials and workmanship for a period of one (1) year, unless otherwise noted, from the date of final acceptance of the project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Owner.
      2. Coating and repair product supplier(s) shall warrant all coating materials for a period of one (1) year from the date of final acceptance, unless otherwise noted, to be free of manufacturing defects; and products will meet current published physical properties when applied and tested in accordance with the manufacturer’s standards. If, within said one (1) year period, any product does not meet the physical properties or is defective in manufacture the manufacturer will either replace the defective product or refund the purchase price.
2. **PRODUCTS**
   1. EXISTING PRODUCTS
3. Standard Portland concrete or new concrete (for quick setting high strength cement see manufacturer’s recommendations) must be well cured prior to application of the protective coating. Generally, 28 days is minimum cure time for standard Portland or when 80% of its design strength has been achieved (see Raven 1010.2014 CATB for coating green concrete).
   * 1. Existing coatings shall be removed which may affect the performance and adhesion of the specified coating product(s). Contractor is to maintain strict adherence to the protective coatings manufacturer's recommendations with regard to proper surface preparation and compatibility with existing coatings.
     2. Thoroughly clean and prepare existing products/surfaces to effect a seal with and promote the adhesion of the coating product(s).
   1. REPAIR PRODUCTS
4. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces, etc. as determined necessary to produce a relatively smooth surface prior to the application of the epoxy coating. Repair materials must be compatible with the specified epoxy coating and shall be applied in accordance with the manufacturer’s recommendations.
   * + 1. Repair materials must be supplied by the coating product(s) manufacturer or be an approved equal product.
       2. In order for a product to be considered an approved equal the submitted product must meet or exceed the minimum characteristics as measured by the applicable standards referenced in paragraphs 2.03 and on the Technical Data Sheets of the approved products. Also be expressly approved by the coating product(s) manufacturer in writing for compatibility with the specified coating product(s).
       3. All materials shall be mixed, applied, and cured in accordance with the manufacturer’s recommendations.
       4. Repair product physical properties shall be substantiated through submittal of accredited third party testing results and shall be representative of the actual field applied product and cure mechanism(s) to be employed in the field.
     1. 100% solids, solvent-free epoxy grout; specifically the specified coating product(s) (Section 2.3 E.)
     2. Factory blended, rapid setting, high-early strength, non-shrink, calcium aluminate repair mortar to be trowel or pneumatically spray applied to the entire surface.
        1. Manufacturer: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810 or 918-615-0140 fax.
        2. Product: Raven 705CA - Cement Mortar having the following characteristics:
           1. Product Type: Calcium aluminate mortar
           2. Tensile Strength, (ASTM C496):>685 psi
           3. Compressive Strength, (ASTM C109): >9200 psi @ 28 days
           4. Flexural Strength, (ASTM C293): >1650 psi
           5. Shrinkage @ 90% R. H. (ASTM C596): 0%
           6. Adhesion to Concrete, (ASTM C882): >4000 psi
           7. Freeze/Thaw (ASTM C666): 100 Cycles, no visible damage
           8. Density of wet mix: 129 – 139 lbs./ft3.
           9. Applied Density: 135 lbs. /ft3 (+/- 5 lbs. /ft3).
     3. Factory blended, rapid setting, high-early strength, non-shrink, Portland cementitious repair mortar to be trowel or pneumatically spray applied to the entire surface.
        1. Manufacturer: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810 or 918-615-0140 fax.
        2. Product: Raven 755 - Cement Mortar having the following characteristics:
           1. Product Type: Portland cement mortar
           2. Tensile Strength, (ASTM C496):>800 psi
           3. Compressive Strength, (ASTM C109): >9,000 psi @ 28 days
           4. Flexural Strength, (ASTM C293): >1500 psi
           5. Shrinkage @ 90% R. H. (ASTM C596): 0%
           6. Adhesion to Concrete, (ASTM C882): >2000 psi
           7. Freeze/Thaw (ASTM C666): 100 Cycles, no visible damage
     4. Factory blended, High Performance Polymer Cement repair mortar to be spray, trowel or otherwise manually applied to the entire surface.
        1. Manufacturer: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810 or 918-615-0140 fax.
        2. Product: Raven 760HPPC – Polymer Cement Mortar having the following characteristics:
           1. Product Type: Polymer Cement Mortar
           2. Tensile Strength, (ASTM C496):>700 psi
           3. Compressive Strength, (ASTM C109): >5120 psi @ 28 days
           4. Compressive Strength, (ASTM C579): >5210 psi @ 28 days
           5. Flexural Strength, (ASTM C580): >1240 psi
           6. Shrinkage @ 90% R. H. (ASTM C596): 0%
           7. Adhesion to Concrete, (ASTM D7234): >200 psi
     5. Factory blended, non-shrink, hydraulic cement to be used for infiltration remediation.
        1. Manufacturer: As applicable
        2. Product: Hydraulic cement having the following characteristics:
           1. Product Type: Hydraulic cement
           2. Compressive Strength, (ASTM C109): >1,000 psi @ 1 hour, >2500 psi @ 24 hours
           3. Shrinkage @ 90% R. H. (ASTM C596): 0%
     6. Hydrophobic or Hydrophilic injectable chemical grout to be used for the remediation of high volume infiltration or crack repair and/or soil stabilization and void filling.
        1. Manufacturer: As applicable
        2. Product: Chemical grout as appropriate for infiltration, crack repair and soil stabilization.
     7. (OPTIONAL) Fiberglass woven roving cloth using E-Glass, 9 oz/yd2 minimum weight; typical of Hexcel or BFG Industries style #7500.
   1. COATING PRODUCTS
      1. Coating product shall be applied to all interior surfaces to protect the host substrate and repair materials from all forms of chemical or bacteriological attack typically found in storm water systems and impart a degree of structural enhancement.
      2. Coating product physical properties shall be substantiated through submittal of accredited third party testing results and shall be representative of the actual field applied product and cure mechanism(s) to be employed in the field.
      3. 100% Solids, Solvent-Free, Ultra-High Build Epoxy Coating to be spray applied to all interior surfaces of exposed concrete above the spring line or as otherwise detailed.
         1. Manufacturer: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810 or 918-615-0140 fax.
         2. Product: Raven 405 – 100% solids, solvent-free ultra high-build epoxy system exhibiting the following characteristics:
            1. Product Type: amine cured epoxy
            2. VOC Content (ASTM D2584): 0%
            3. Compressive Strength, (ASTM D695): >18,000 psi
            4. Tensile Strength, psi (ASTM D638): >7,600 psi
            5. Flexural Modulus, psi (ASTM D790): >700,000 psi
            6. Adhesion to Concrete, (ASTM D4541/7234): >200 psi with substrate (concrete) failure
            7. Chemical Resistance (ASTM D543/G20) immersion service for:
5. Municipal sanitary sewer environment
6. Sulfuric Acid, 30%
7. Sodium Hydroxide, 10%
8. Sodium Hypochlorite, 3%
   * + - 1. Successful Pass: Sanitation District of L.A. County Coating Evaluation Study and SSPWC 210.2.3.3 (Greenbook “Pickle Jar” Chemical Resistance test)
     1. 100% Solids, Solvent-Free, Ultra-High Build Epoxy Coating to be manually or spray applied to interior surfaces of exposed concrete above or below the typical flow line; specifically designed for accelerated cure and suitable for release of flow in less than 45 minutes at normal service temperatures or as otherwise detailed.
        1. Manufacturer: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810 or 918-615-0140 fax.
        2. Product: Raven 405 FS – 100% solids, solvent-free ultra high-build epoxy system.
           1. Product Type: amine cured epoxy
           2. VOC Content (ASTM D2584): 0%
           3. Compressive Strength, (ASTM D695): >16,000 psi
           4. Tensile Strength, psi (ASTM D638): >7,600 psi
           5. Flexural Modulus, psi (ASTM D790): >688,000 psi
           6. Adhesion to Concrete, (ASTM D4541/7234): >200 psi with substrate (concrete) failure
           7. Chemical Resistance (ASTM D543/G20) immersion service for:
9. Municipal sanitary sewer environment
10. Sulfuric Acid, 30%
11. Sodium Hydroxide, 10%
12. Sodium Hypochlorite, 3%
    * 1. 100% Solids, Solvent-Free, Ultra-High Build Epoxy Coating to be trowel or otherwise manually applied to interior surfaces of exposed concrete above the spring line or as otherwise detailed (405 trowel can be applied with or without the addition of the component part C for a standalone coating or a glaze coat application).
         1. Manufacturer: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810 or 918-615-0140 fax.
         2. Product: Raven 405 Trowel – 100% solids, three component solvent-free ultra high-build epoxy system.
            1. Product Type: amine cured epoxy
            2. VOC Content (ASTM D2584): 0%
            3. Compressive Strength, (ASTM D695): >11,200 psi
            4. Compressive Strength without part C , (ASTM D695): >18600 psi
            5. Tensile Strength, (ASTM D638): >4,000 psi
            6. Tensile Strength without part C, (ASTM D638): >4,900 psi
            7. Flexural Modulus, (ASTM D790): >806,000 psi
            8. Flexural Modulus without part C, (ASTM D790): >810,000 psi
            9. Adhesion to Concrete, (ASTM D4541/7234): >200 psi with substrate (concrete) failure
            10. Chemical Resistance (ASTM D543/G20) immersion service for:
13. Municipal sanitary sewer environment
14. Sulfuric Acid, 30%
15. Sodium Hydroxide, 10%
16. Sodium Hypochlorite, 3%
    * 1. (OPTIONAL) Coating product primer to be applied to concrete or masonry as recommended by the coating product manufacturer as installation conditions warrant.
         1. Manufacturer: Raven Lining Systems, Broken Arrow, Oklahoma 800-324-2810 or 918-615-0140 fax.
         2. Product: Raven 171 – 100% solids epoxy primer
            1. Product Type: amine cured, epoxy primer
         3. Product: Raven 171FS – 100% solids epoxy primer
            1. Product Type: amine cured, epoxy primer
         4. Product: Raven 155 – Water borne epoxy primer
            1. Product Type: amine cured, waterborne epoxy primer
    1. PRODUCT APPLICATION EQUIPMENT
       1. Cementitious repair products for spot repair may be mixed and applied using hand and/or power tools
       2. Cementitious repair products to be spray applied shall be mixed and applied using manufacturer approved batch mixing and low velocity spray devices.
       3. Coating product primer may be applied using hand tools or other convention/airless spray application device(s).
       4. Coating product to be spray applied shall be mixed and applied using manufacturer approved heated plural component spray equipment.
       5. Coating product application to hard to reach areas or for touch-up may be performed using hand tools.
17. **EXECUTION**
    1. EXAMINATION
       1. Appropriate actions shall be taken by Contractor to comply with local, state, and federal regulatory and other applicable agencies with regard to environment, health, and safety during work.
       2. All structures to be coated shall be readily accessible to Contractor.
       3. New Portland concrete structures shall have a minimum of 28 days cure since manufacture prior to commencing coating installation. Should earlier coating be required, coating product manufacturer shall recommend specifications including appropriate cure assessment testing and use of specialty primers and sealers such as Raven 155.
       4. Any active flows shall be dammed, plugged, or diverted as required to ensure all liquids are maintained below or away from the surfaces to be coated until final applications are cured as recommended by the manufacturer.
       5. Temperature of the surface to be coated should be maintained between 40 and 120 °F.
       6. Specified surfaces should be shielded to avoid exposure of direct sunlight, other intense heat source or, where cementitious products are employed, excessive ventilation. Where varying surface temperatures do exist, coating installation should be scheduled when the temperature is falling versus rising.
       7. Prior to commencing surface preparation, Contractor shall inspect all surfaces specified to receive the coating and notify Owner, in writing, of any noticeable disparity in the site, structure or surfaces which may interfere with the work, use of materials or procedures as specified herein.
    2. REPAIRS AND SURFACE PREPARATION
       1. Excessive debris, sediment, root intrusion or other foreign materials which may impact the effectiveness of the surface preparation process shall be removed prior to the commencement thereof.
       2. Offset structural components, lids, covers, frames, etc. shall be repaired, replaced, or reset prior to the commencement of surface preparation.
       3. External soil/fill voids shall be remediated and/or stabilized by replacement or injection of stabilizing grout as determined appropriate by the engineer.
       4. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed in accordance with SSPC-SP 1 – Solvent Cleaning.
       5. Choice of surface preparation method(s) should be based upon the condition of the structure and concrete or masonry surface, potential contaminants present, access to perform work, and the required cleanliness and profile of the prepared surface to receive the repair and/or coating product(s).
       6. Surface preparation method, or combination of methods, that may be used include high-pressure water cleaning, water jetting, abrasive blasting, shot blasting, grinding, scarifying, detergent water cleaning, hot water cleaning and others as referenced in industry accepted standards such as:
          1. SSPC SP-13/NACE No. 6 Surface Preparation of Concrete,
          2. ASTM D-4258 Standard Practice for Surface Cleaning Concrete for Coating and ASTM D4259 Standard Practice for Abrading Concrete,
          3. ICRI Technical Guideline No. 03732 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
          4. NACE/SSPC Standards for the surface preparation of steel.
       7. Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound, clean, and neutralized surface suitable for the specified coating product(s).
          1. Resulting surface profile of the prepared concrete substrate shall be (as described in ICRI Technical Guideline No. 03732):
             1. For application of cementitious materials; at least a CSP5
             2. For application of coating products: at least a CSP4.
          2. Concrete and/or mortar damaged by corrosion, chemical attack or other means of degradation shall be removed so that sound substrate remains,
             1. In conditions where severe chemical/microbiological attack is present the prepared substrate shall exhibit a pH of 8-12. Additional cleaning and/or contaminated substrate removal may be required to achieve the specified pH level.
          3. Steel surfaces to be coated shall be abrasive blast cleaned.
             1. Blast air shall be free of oil and water.
             2. Abrasive shall be as required to produce the specified level of cleanliness and profile in an efficient and uniform manner. Abrasive shall not be recycled.
             3. Abrasive blasting shall not be performed when the air or steel temperature is below 40 deg F, when the relative humidity exceeds 80%, or when the steel is less than 5 deg F warmer than the dew point. The Contractor will provide dehumidification, and/or temperature control as necessary to meet these conditions.
             4. Blast cleaning shall be in accordance with SSPC-SP 5, White Metal Blast Cleaning for immersion service of the coated areas. Blast cleaning for other surfaces shall be in accordance with SSPC-SP 10, Near White Blast Cleaning. Anchor profile shall be 2.5-5.0 mils and relative to the coating thickness specified.
             5. Alternatively, surfaces to be recoated may be cleaned according to SSPC-SP 12/NACE No. 5 Surface Preparation and Cleaning of Metals by Water jetting prior to Recoating.
18. Preparation shall be to SSPC-SP 12, WJ-1, and Clean to Bare Substrate using a minimum of High-Pressure Water Jetting (10,000-30,000 psi).
19. Water jetting does not produce a profile of the magnitude currently recognized by the coatings industry. Rather, it exposes the original abrasive-blasted surface profile if one exists. An anchor profile of at least 2.5 mils is required to be exposed. If sufficient profile does not exist, abrasive blasting shall be performed as specified in section 3.2 D.
20. At the time of the recoating, the amount of flash rust shall be no greater than “No Flash Rust” as defined in SSPC-SP 12.
21. If inhibitors are to be used with the standard jetting water, the coatings manufacturer shall be consulted to ensure the compatibility of inhibitors with the coatings.
    * 1. Prior to the application of the coating product repairs shall be completed to ensure the following:
         1. All inflow and infiltration shall be eliminated by use of appropriate repair material(s), such as hydraulic cements and/or chemical grouts as described in Section 2.2.
         2. All repairs to joints, pipe seals, steps, mechanical penetrations, benches, inverts, pipes or other appurtenances to be coated shall be completed and repaired surfaces prepared according to this section.
            1. Benches or other horizontal surfaces shall have adequate slope (1” rise per lineal foot) to minimize the retention of debris following surcharge.
            2. Inverts or flow channels shall be smooth without lips, rough edges or other features which may cause debris to collect; contoured to minimize turbulent flow; and be sloped to promote adequate flow from the inlet(s) to the outlet pipe.
            3. All joints, pipe seals, steps or other penetrations shall be sealed against inflow, infiltration and exfiltration and be adequately filled, smoothed and contoured to promote monolithic coating application.
      2. Areas where reinforcing steel has been exposed shall be repaired in accordance with the Project Engineer’s recommendations or at the minimum all exposed steel shall be prepared in accordance with Section 3.2 prior to coating with the coating product specified or other approved primer as specified by the coating product manufacturer.
    1. APPLICATION OF REPAIR AND RESURFACING PRODUCTS
    2. Repair products as per section 2.2 C, D, shall be used to repair, smooth or rebuild surfaces with rough profiles to provide a concrete or masonry substrate suitable for the coating product(s) to be applied. These products shall be installed to 1/2” minimum thickness or as recommended within manufacturers published guidelines. Should structural rebuild be necessary, these products shall be installed to a thickness as specified by the Project Engineer
    3. Repair products as per section 2.2 E shall be used to fill voids, bug holes, and other surface defects which may affect the performance or adhesion of the coating product(s). These products shall be installed to 1/16” minimum thickness to 1/4”or as recommended within manufacturers published guidelines.
    4. Repair products as per section 2.2 F and/or G shall be used to remediate all active inflow, infiltration, and/or external soil/fill voids.
    5. All Repair products shall be handled, mixed, installed, and cured in accordance with manufacturer guidelines.
    6. All repaired or resurfaced substrates shall be inspected for cleanliness and suitability to receive the coating product(s). Additional surface preparation may be required prior to coating application as per section 3.2.
    7. (OPTIONAL) Fiberglass woven roving cloth may be rolled into the coating for added tensile and flexural strength where desired and/or required.
       1. A tack coat of a minimum of 20-30 mils shall be applied and allowed to cure to a tack free state, followed by and additional coat of 20-30 mils of coating into which the fiberglass matte shall be inlayed and rolled while wet, an additional 50-60 mil coat minimum shall be applied over the fiberglass inlay as part of the overall coating application.
       2. Fiberglass matte shall be woven roving cloth with an approximate weight of 9 oz/yd2. Fiberglass matte shall be rolled into the epoxy tack coat(s) using a notched roller fully relieving trapped air and wrinkles. The final topcoat shall encapsulate all fiberglass strands. Care should be taken to ensure adequate cure time between applications above 100 mils to relieve exothermic heat in order to avoid thermal degradation of the coating.
    8. APPLICATION OF COATING PRODUCT(S)
       1. Application procedures shall conform to the recommendations of the coating product(s) manufacturer, including environmental controls, product handling, mixing, application equipment, and methods.
       2. Spray equipment shall be specifically designed to accurately ratio and apply the coating product(s) and shall be in proper working order.
       3. Contractors qualified in accordance with Section 1.4 of these specifications shall perform all aspects of coating product(s) installation.
       4. Prepared surfaces shall be coated via spray application of the coating product(s) described herein unless otherwise recommended by the coating product manufacturer.
       5. Coating thickness shall be in relation to the profile of the surface to be coated as recommended by the coating product manufacturer.
       6. In all cases the coating product(s) shall be applied to a minimum dry film thickness of 60 mils to surface profiles of CSP-4 to CSP-5 or 100 mils minimum DFT to surface profiles of CSP-6 or greater and in rehabilitated structures.
          1. For resistance to ground water head pressure coating manufacture for recommendations.
       7. Subsequent top coating or additional coats of the coating product(s) shall occur within the products recoat window or 24 hours whichever is less. Additional surface preparation procedures will be required if this recoat window is exceeded.
       8. Coating product(s) shall interface with adjoining construction materials/components throughout the manhole structure to effectively seal and protect substrates from attack by corrosive elements and to ensure the effective elimination of infiltration into the sewer system.
       9. Procedures and materials necessary to effect the interface between dissimilar materials and the coating product shall be as recommended by the coating product(s) manufacturer.
       10. Termination points of the coating product(s) shall be made at the manhole frame and chimney joint (or other man way as is present), 1” below normal flow levels at the bench or within the invert [unless invert is specified to receive coating], and a minimum of 1” interfacing within each pipe penetration.
       11. (Pipeline only) Coating product(s) shall interface with adjoining construction materials throughout the pipeline to effectively seal and protect concrete or masonry substrates from infiltration and attack by corrosive elements. Procedures and materials necessary to effect this interface shall be as recommended by the coating product(s) manufacturer.
       12. (Pipeline only) Termination points of the coating product(s) shall be made at each manhole joint, 1” below normal flow levels (when less than 360o coating application is being specified), and a minimum of 1” interfacing with each pipe penetration. When less than 360o of the pipe is to be coated, the coating shall be terminated at a saw cut key-in within the pipe.
       13. Flow shall be stopped, bypassed, or diverted as necessary for application of the coating product(s) to the invert and interface with pipe materials.
    9. TESTING AND INSPECTION
       1. Coating system thickness shall be inspected to ensure compliance with the specifications herein.
          1. During application a wet film thickness gauge, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, documented, and attested to by Contractor for submission to Owner.
          2. After the coating product(s) have cured in accordance with manufacturer recommendations, coating system thickness may be measured according to SSPC-PA 9 - Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages.
       2. High voltage holiday detection for coating systems installed in corrosive environments, when it can be safely and effectively employed, shall be performed to ensure monolithic protection of the substrate. After the coating product(s) have cured in accordance with manufacturer recommendations, all surfaces shall be inspected for holidays in accordance with NACE RPO 188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates or ASTM D4787 Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates. All detected holidays shall be marked and repaired according to the coating product(s) manufacturer’s recommendations.
          1. Test voltage shall be a minimum of 100 volts per mil of coating system thickness.
          2. Detection of a known or induced holiday in the coating product shall be confirmed to ensure proper operation of the test unit.
          3. All areas repaired shall be retested following cure of the repair material(s).
          4. In instances where high voltage holiday detection is not feasible a close visual inspection shall be conducted and all possible holidays shall be marked and repaired as described above.
          5. Documentation of areas tested, equipment employed, results, and repairs made shall be submitted to the Owner/Engineer by Contractor.
       3. Adhesion of the coating system to the substrate shall be confirmed in a minimum of 10% of the areas coated, or for large structures once every 1000 square feet of coated area. After the coating product(s) have cured in accordance with manufacturer recommendations, testing shall be conducted in accordance with ASTM D7234 Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers. Owner’s representative shall select the areas to be tested.
          1. For each test manhole a minimum of three 20 mm dollies shall be affixed to the coated surface; one at the cone area, one at the mid section and one near the bottom of the structure.
          2. For larger structures a minimum of three 20 mm dollies shall be affixed to the coated surface at random locations within each 1000 square foot area or as otherwise agreed upon.
          3. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of at least twice the anticipated failure point (generally at least 1000 psi) and permitted to cure in accordance with manufacturer recommendations. The coating and dollies shall be adequately cleaned and prepared to receive the adhesive. Failure of the dolly adhesive shall be deemed a non-test and require retesting.
          4. Prior to performing the pull test, the coating shall be scored to the substrate, or within 10 mils of the substrate surface, by mechanical means without disturbing the dolly or coating system bond within the test area.
          5. Two of the three adhesion pulls in each test area shall exceed 200 psi and shall include substrate adhered to the back of the dolly or no visual signs of the coating product in the test hole. Pulls tests with results between 150 and 200 psi may be acceptable if more than 50 percent of the substrate in the test area is adhered to the dolly.
          6. Should a structure, or area, fail to achieve two successful pulls as described above, additional testing shall be performed at the discretion of the Owner or Project Engineer. Any areas detected to have inadequate bond strength shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor.
          7. All adhesion testing shall be performed by qualified personnel using calibrated equipment as specified by the applicable ASTM standard(s).
          8. All adhesion testing shall be documented and submitted in a consistent format detailing location, test values, description of the failure point/mode, scoring method employed, adhesive used, cure time of coating and adhesive and other data as deemed necessary by the owner/engineer.
          9. All adhesion test locations shall be repaired by the Contractor at no cost to the Owner.
       4. Visual inspection shall be made by the Project Engineer and/or Inspector. Any deficiencies in the finished coating affecting the performance of the coating system or the operational functionality of the structure shall be marked and repaired according to the recommendations of the coating product(s) manufacturer.
       5. The system may be returned to full operational service as soon as the final inspection has taken place and all coating materials have been adequately cured according to the coating product(s) manufacturer’s recommendations.

**END OF SECTION**