SPECIFYING PROTECTION SYSTEMS

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Black & Veatch
Engineer–Contractor

Consulting Engineer

- International Specialist
  - Concrete, Corrosion, and Specifications
- Standards Committees
  - ACI (9) and ASTM (2)
- Memberships
  - NACE, SSPC, ACI, ASTM, SAME, AEI

Consulting Engineer

- Works for the Client/Owner
- Enforces specification with
  - Contractor
  - System manufacturer
  - Approved applicator

GOAL

- Client/Owner receives the necessary and acceptable protection systems
  - Understand the substrate
  - Determine most economical protection system
  - Select acceptable system manufacturers
  - Develop a strong unambiguous and constructible specification
  - Enforce the specification during construction

Types of System Failures

Detail A--Adhesive Failure of Coating:
coating separates cleanly from the substrate

Detail B--Cohesive Failure of Coating:
coating breaks within itself and not at the substrate

Detail C--Cohesive Failure of Substrate:
coating removal separates the substrate.

TYPICAL SUBSTRATES

- Steel
- Concrete
- Others

Steel Substrate

- Properties and Characteristics
  - Strength
  - Density
- Evaluate the condition of substrate
- Determine SSPC criteria for preparation of substrate
  - Clean
  - Profile

Concrete Substrate

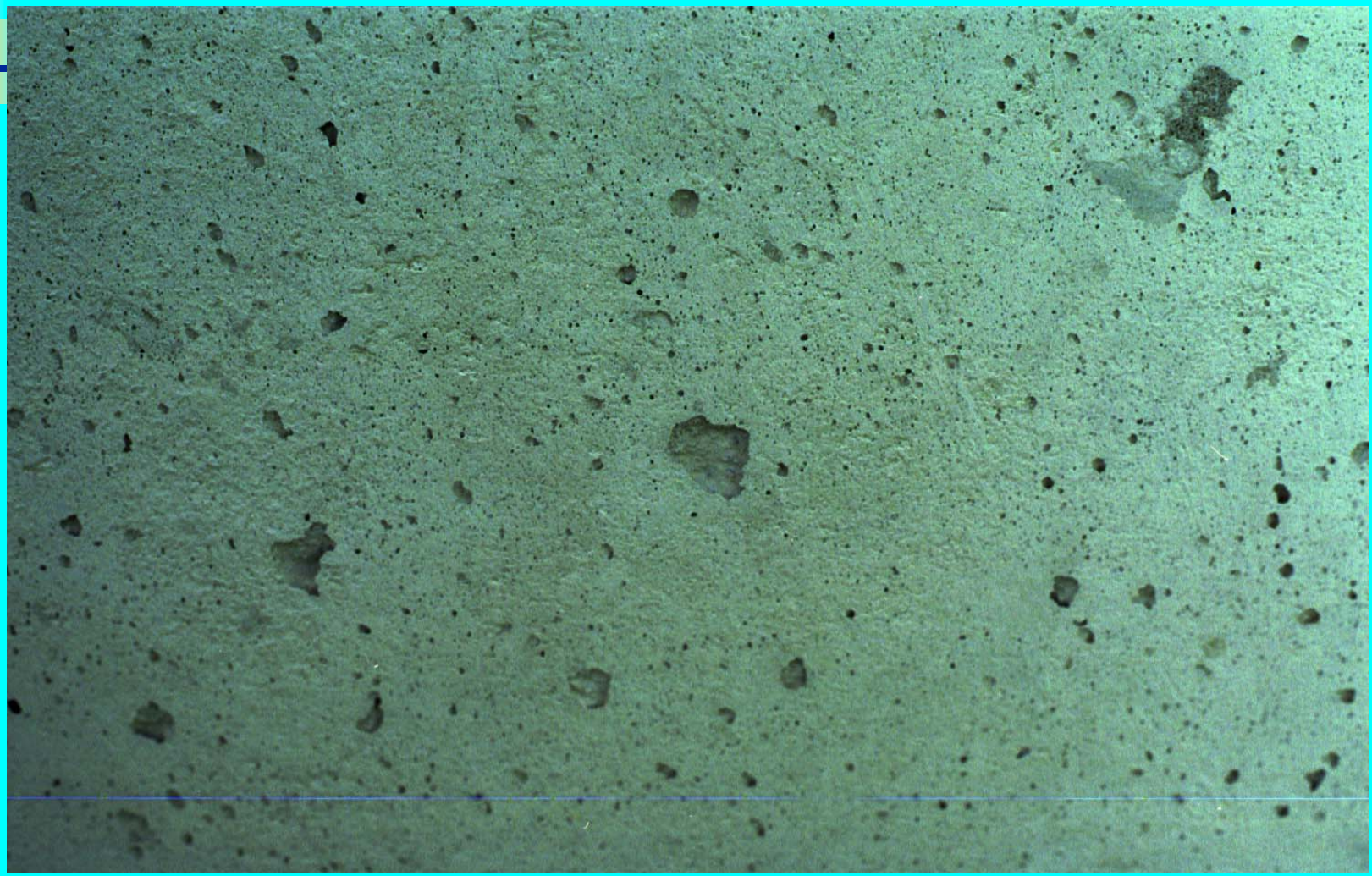
- Properties and Characteristics
  - Strength
  - Density
- Evaluate the condition of substrate
- Determine criteria for preparation of substrate using SSPSC SP-13/NACE 6

Concrete Field Condition Considerations

- Moisture content
- Moisture migration
- Strength of concrete
- Concrete quality

Tie Hole

Bug Holes

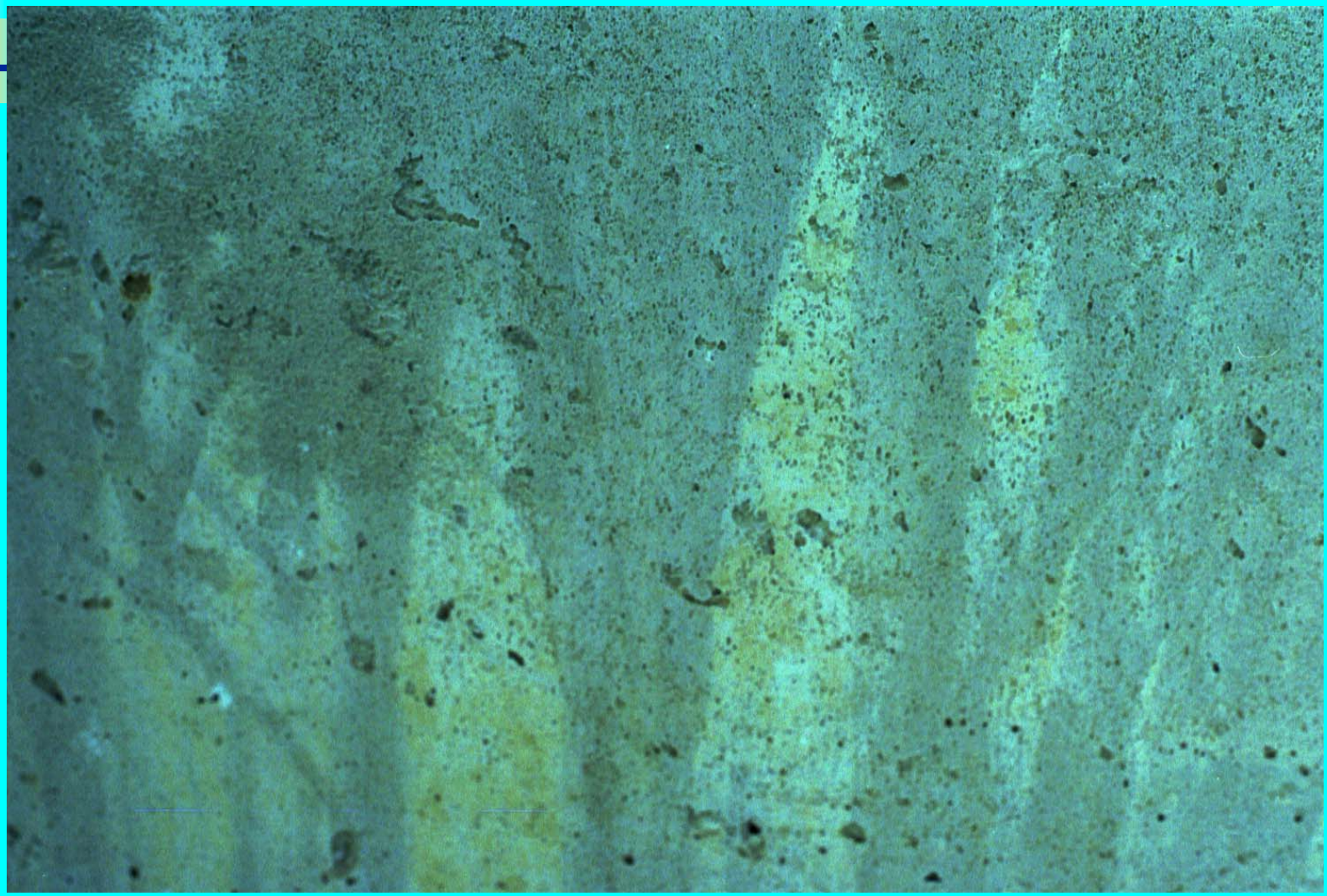


Honeycomb

Cracks

Leakage

Efflorescence



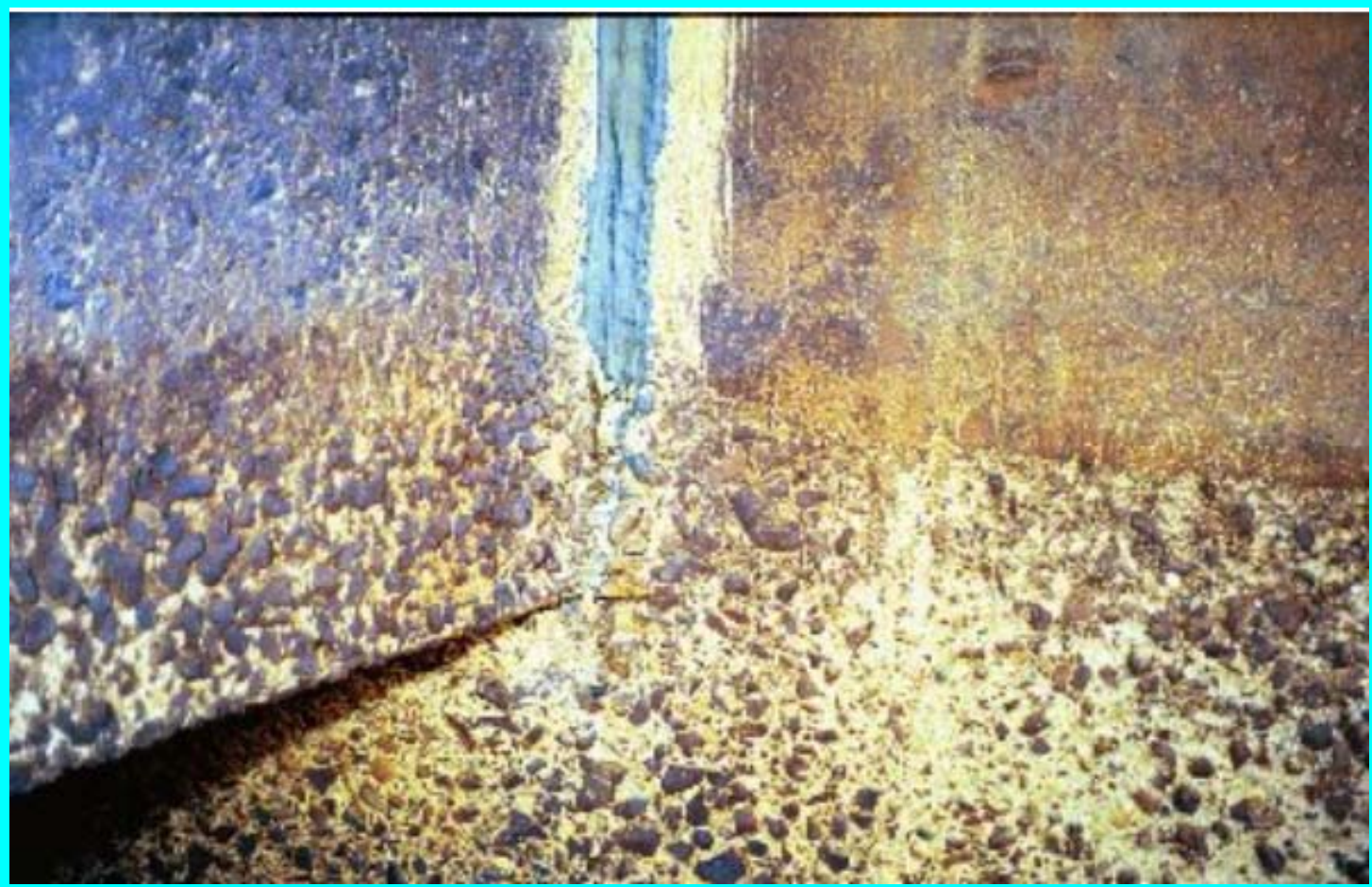
Concrete Spalling Coating Failure

Other Concrete Conditions

- Laitance
- Concrete splatter
- Curing compounds
- Form burrs and sharp projections
- Foreign objects

Concrete Void/ Exposed Reinforcement

Chemical Corrosion



Sulfuric Acid Corrosion

Failed Corrosion Protection System

Damaged Concrete Surface

Concrete Staining

GENERAL ENGINEERING REQUIREMENTS

- Specification Criteria
- Evaluation of Protection Systems
- Evaluation of System Manufacturers
- Specification Guidelines
- Evaluation of Contractor Submittals

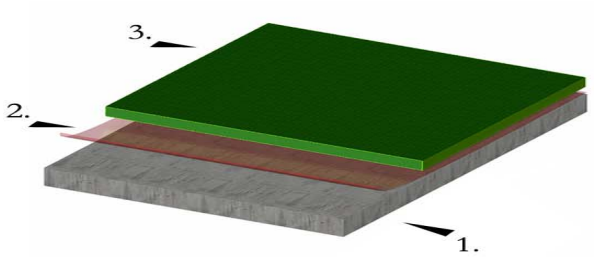
SPECIFICATION CRITERIA

- Determine Conditions of Service
- Evaluate Types of Protection Systems
- Establish Minimum Criteria
- Determine Manufacturers' Responsibilities
- Establish Submittal Requirements

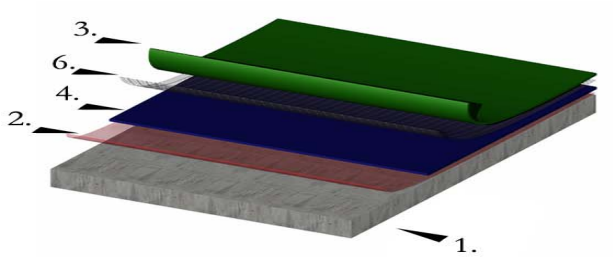
PROTECTION SYSTEMS

- Protective Coatings
- Protection Systems
  - Linings
    - Rigid
    - Flexible
  - Toppings

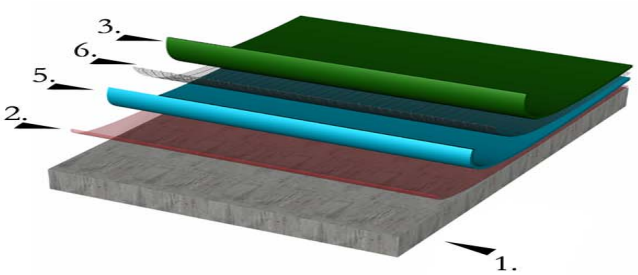
Protection Systems Details



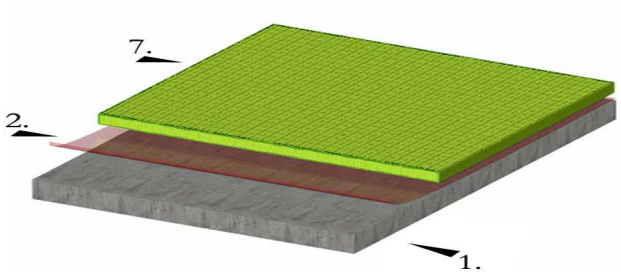
Detail A: Coating System



Detail B: Rigid Lining System

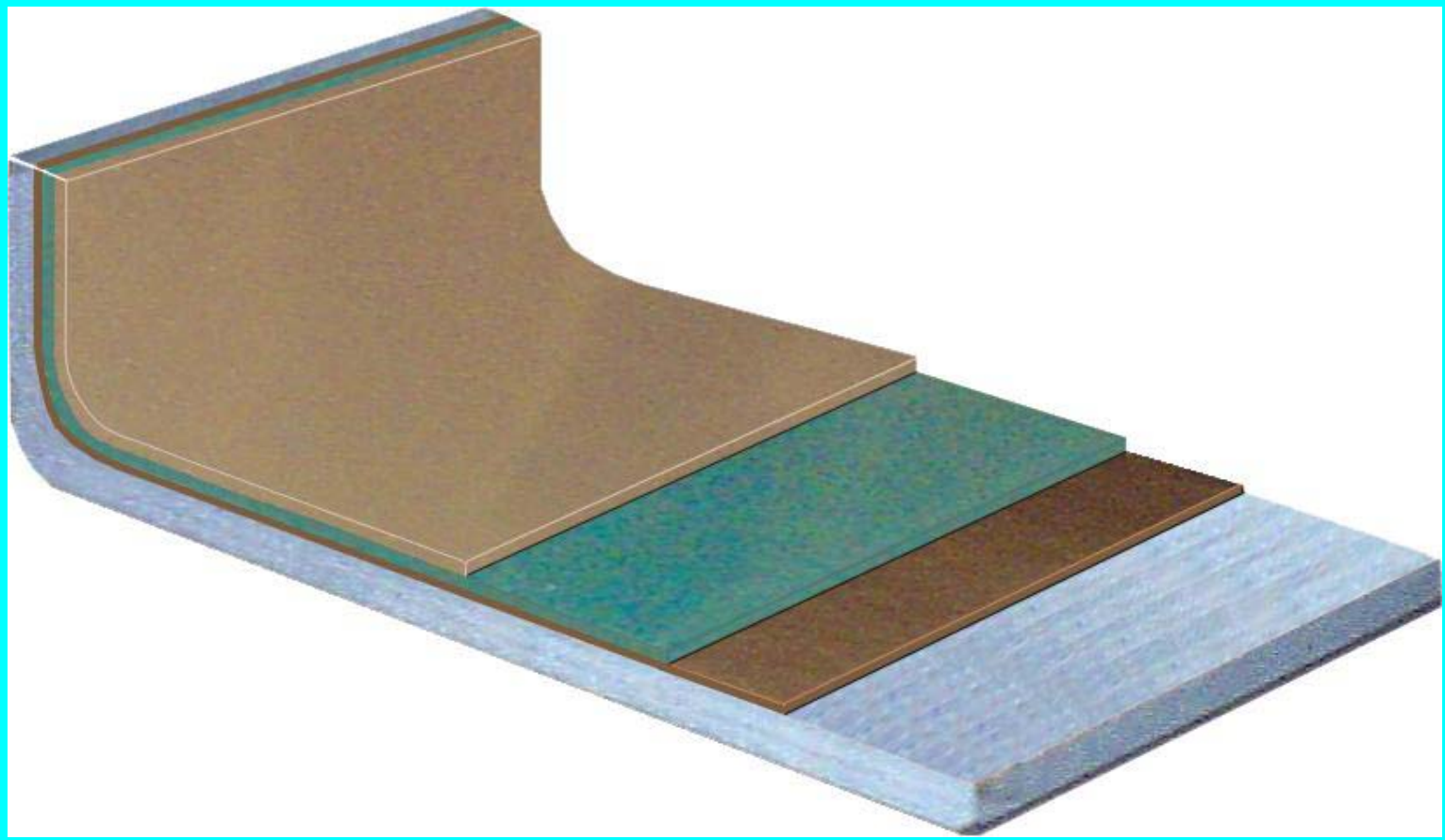


Detail C: Flexible Lining System

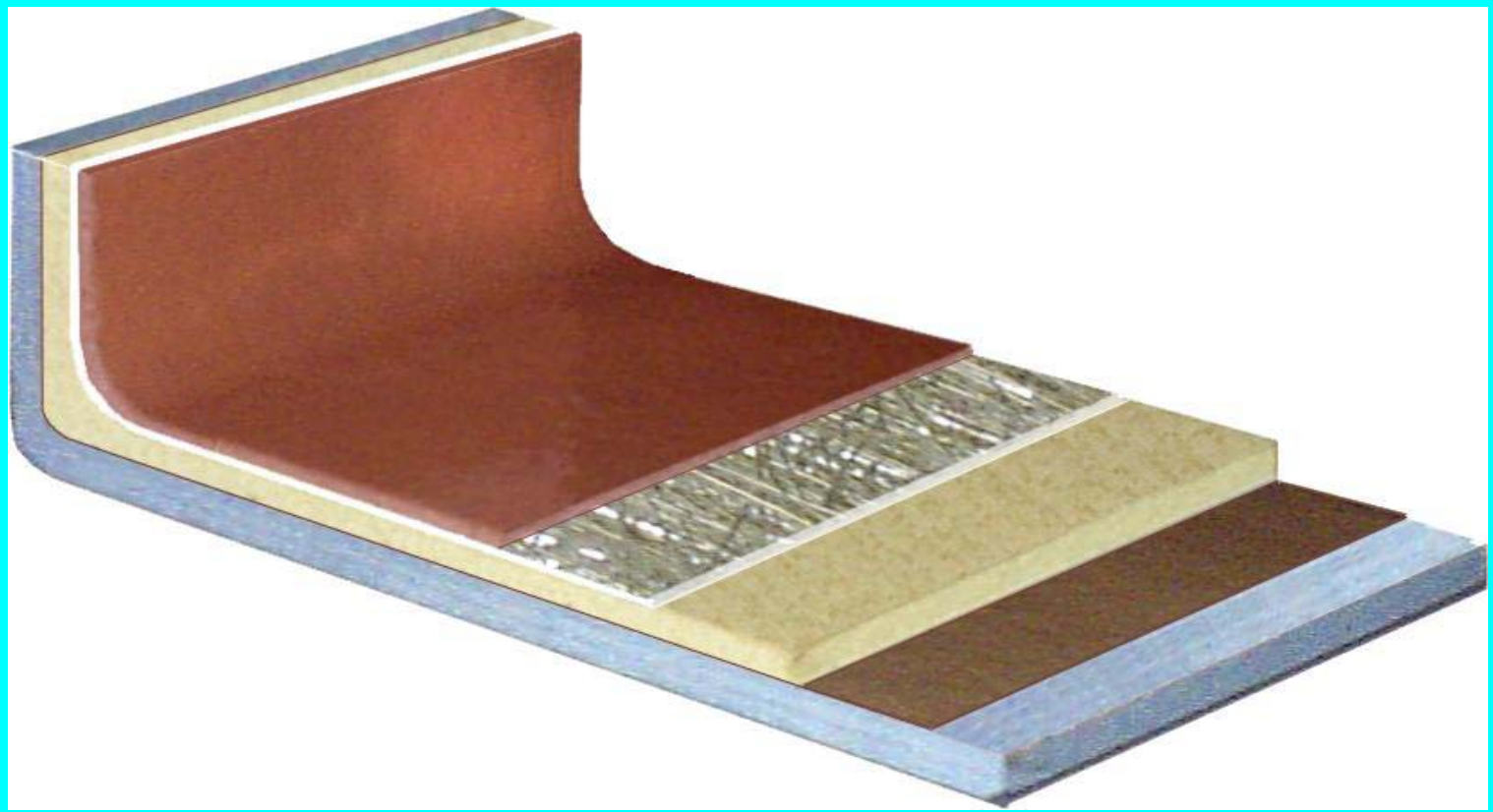


Detail D: Topping System

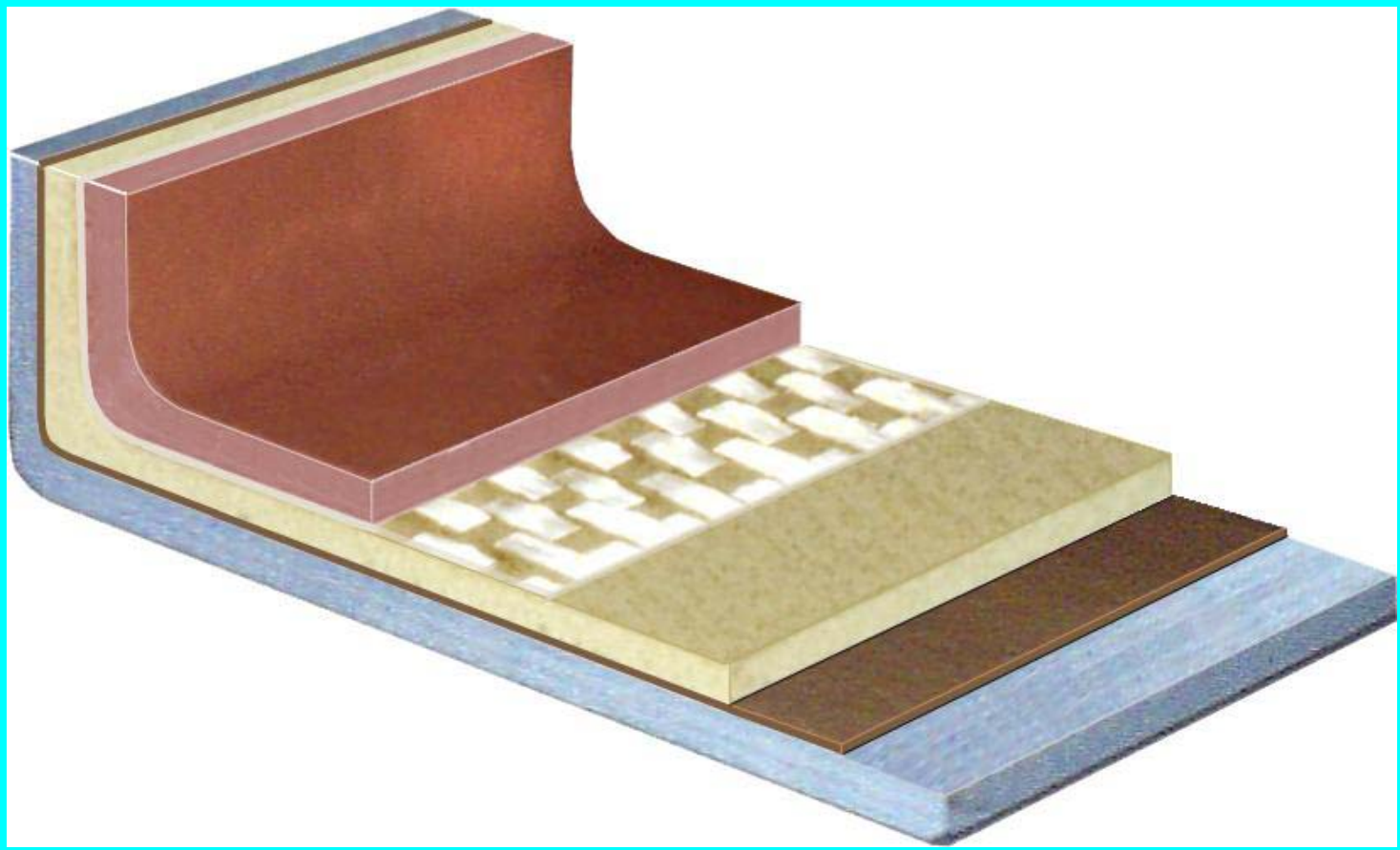
Coating Protection System



Reinforced Basecoat Protection System



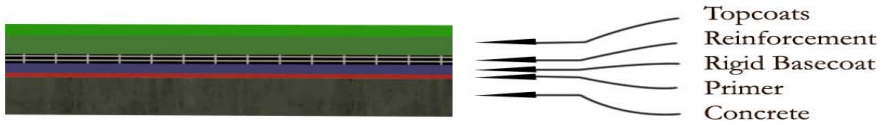
Flexiblized Basecoat Protection System



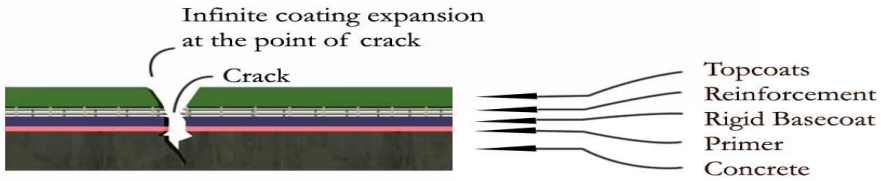
Flexible Systems

- Polyurea Systems
- Polyureathane Systems

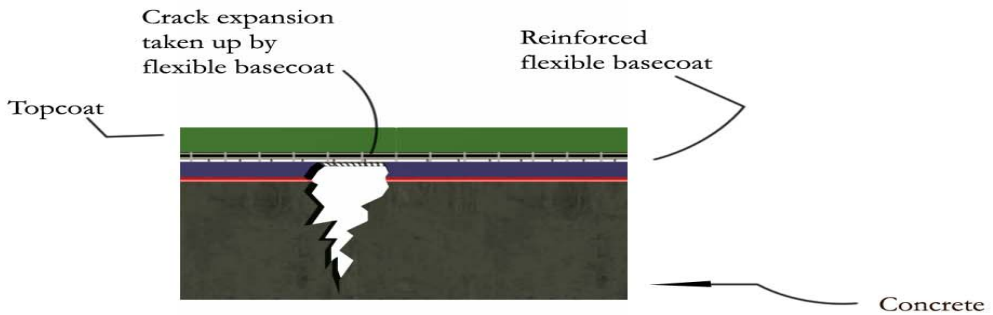
Systems on Concrete



(a) Corrosion Protection System on Concrete: Before Cracking of Concrete

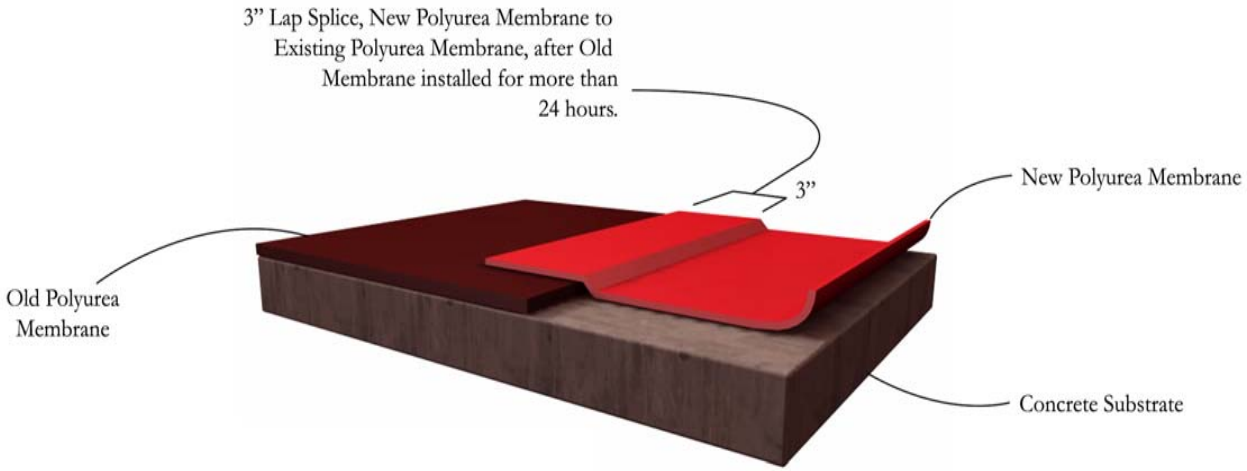


(b) Corrosion Protection System on Concrete: After Cracking of Concrete with a Reinforced Rigid Basecoat (NOT RECOMMENDED)



(c) Corrosion Protection System on Concrete: After Cracking of Concrete with a Reinforced Flexible Basecoat (RECOMMENDED)

Repair of System



(A)

Tie-in at Old Polyurea Membrane, horizontal or vertical

EXISTING POLYUREA MEMBRANE PREP:

1. Wipe Existing Membrane with Denatured Alcohol.
2. Apply Primer.
3. Apply Polyurea.

New Membrane to Existing Membrane

Conditions of Service

- Expected exposure conditions
  - Maximum temperatures of corrosive materials and substrate
  - Maximum concentration of corrosive materials
  - Expected environmental conditions

Minimum Criteria

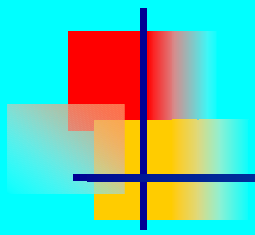
- Minimum exposure time
- Minimum thickness of system
- Expected performance

Manufacturers' Responsibilities

- Overall responsibility for application
- Approve applicator
- Approve surface preparation
- Approve application
- Certify applied system holiday free
- Provide required warranty

Submittal Requirements

- Manufacturers approvals
- Proposed system specifications and data
- Testing reports required



EVALUATION OF POTENTIAL SYSTEMS & MANUFACTURERS

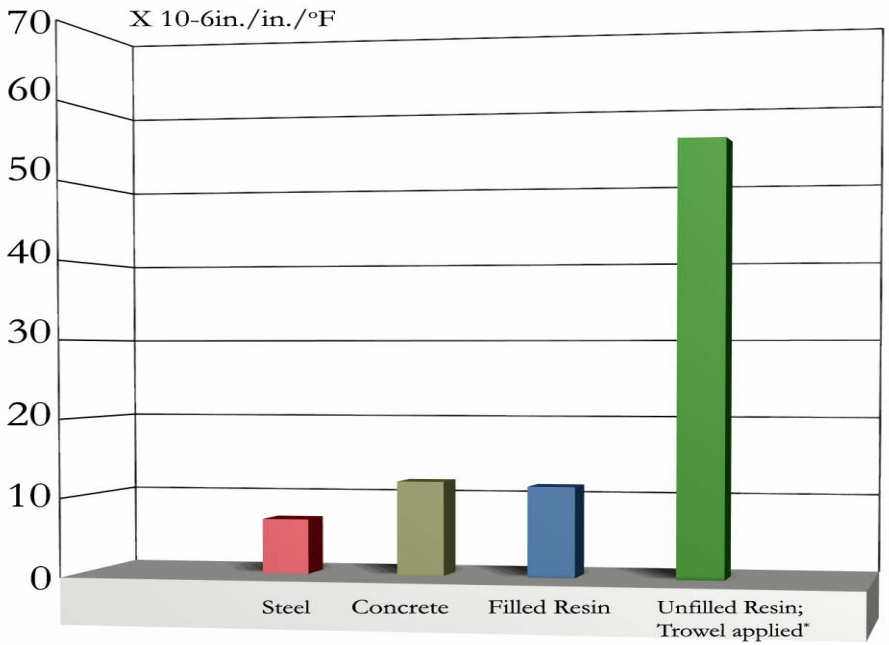
Preliminary Evaluations

- Potential Protection Systems
- Potential System Manufacturers

Potential Protection Systems

- Rigid coating systems
- Reinforced rigid systems
- Flexible systems
- Reinforced flexible systems

Coefficients of Expansion



* Unfilled resin coefficient of expansion is 8.5 times more than steel and 4.5 times more than concrete.

Potential Systems Manufacturers

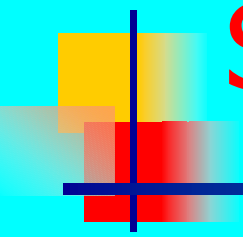
- Identify potential manufacturers
- Contact the potential manufacturers
- Preliminary review of information
- Verify proposed systems are suitable

Detailed Evaluation of System Manufacturer

- Evaluation of the manufacturers technical knowledge
- Evaluation of manufacturers ability to resolve problems

Detailed Evaluation of Protection System

- Verify system suitable for service conditions
- Verify published literature is compliance with established criteria

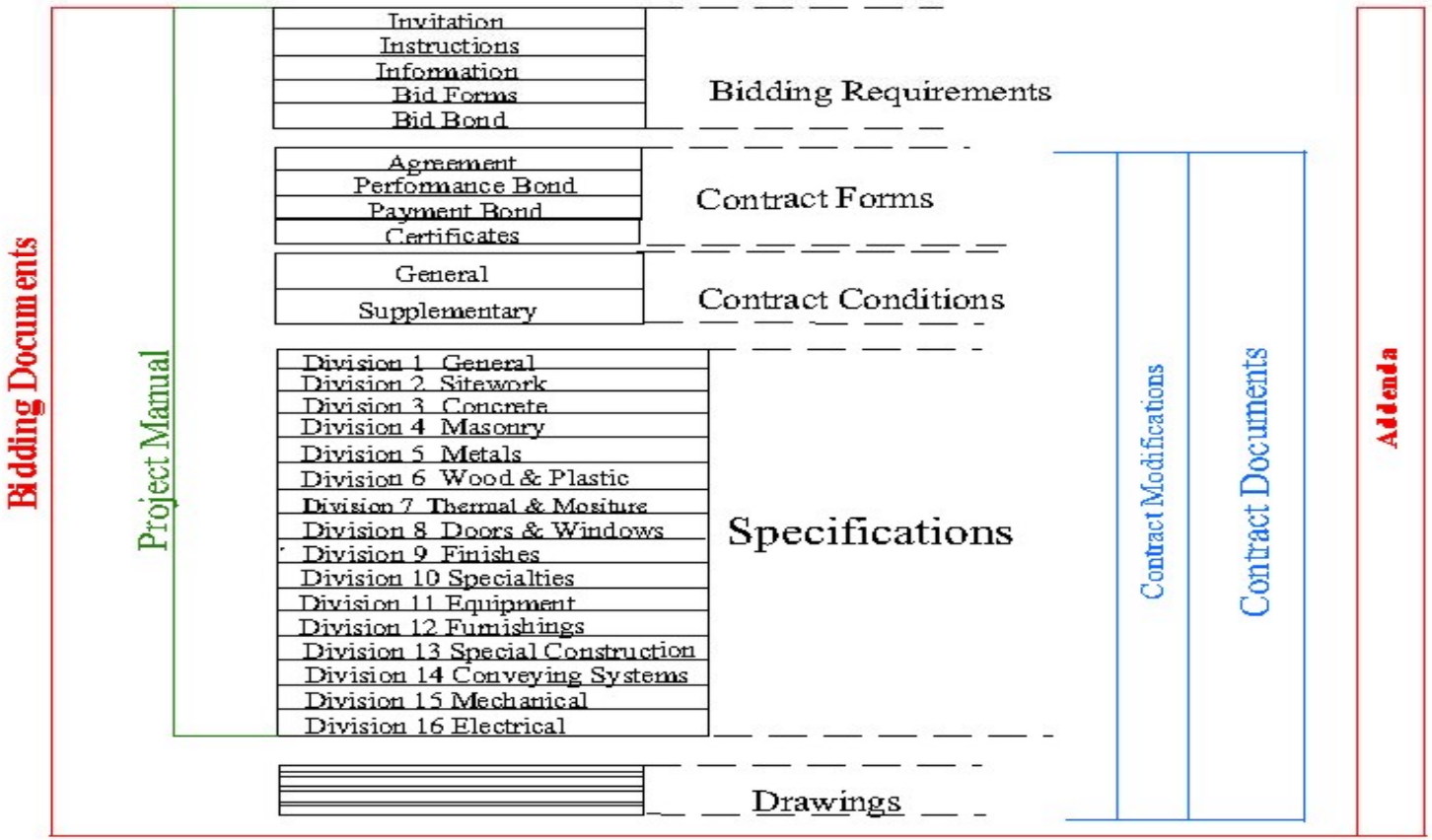


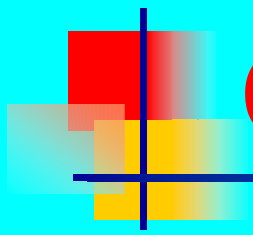
SPECIFICATION GUIDELINES

Development and Organization

Bidding & Contract Documents

Document Map of a Construction Project





General

- Establish minimum requirements
- Use CSI three-part based format
- State limiting requirements
- Specify expected performance

Project Specification

- Coatings and Linings - Division 9
- Numbering of sections
  - 09880 and 09890 series of numbers for protection systems
  - 09900 series of numbers for coatings

CSI Three-Part Section Format

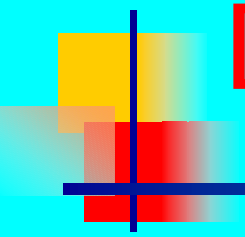
- Part 1
  - Scope
  - Qualifications
  - Submittals
  - Delivery, Storage, and Handling
  - Warranty

CSI Section Format (continued)

- Part 2 - Products
  - Conditions of Service
  - Materials / Systems

CSI Section Format (continued)

- Part 3 - Execution
  - Surface Preparation
  - Mixing and Thinning
  - Application
  - Field Quality Control
  - Protection of Adjacent Surfaces



Developing a Specification

Criteria and Examples

Scope Paragraphs

1-1. SCOPE. This section covers furnishing and installation of a xxxx xxxx corrosion protection system to be applied to the floor and walls of the chemical storage facilities as indicated on the drawings.

Scope Paragraphs (continued)

This section covers concrete surface preparation, furnishing, and application of the corrosion protection system suitable for the specified service conditions, the engineering field services to be provided by the material manufacturer that are required, and any appurtenances required to provide a complete corrosion protection system.

Qualifications

- Manufacturers' Field Service
- Applicator Requirements

Manufacturers' Field Service

Manufacturers' Field Services Paragraphs

1-2.01. Manufacturer's Field Services. The applicator of the protection system shall contact the protection system material manufacturer during the bidding phase of the project and shall include in the cost of this work the estimated cost of the manufacturer's engineering field services as specified.

Manufacturers' Field Services Paragraphs (continued)

The field services provided by the material manufacturer shall include review of the project before surface preparation; approving the applicator, the materials, and the procedure to be used; provide the adhesion testing, if testing for adhesion is required to determine compliance with the specified minimum pull-off adhesion strength; observation and approval of the surface preparation; and observing the application.

Manufacturers' Field Services Paragraphs (continued)

The field representative of the protection system material manufacturer shall submit, through Contractor, written approvals of the proposed protection system materials, application procedures, applicator, and surface preparation. The field representative shall be an employee of the material manufacturer.

Manufacturers' Field Services Paragraphs (continued)

Contractor shall notify the material manufacturer and Engineer at least 10 days prior to anticipated date of placement of the topping.

Applicator

Applicator Paragraph

1-2.02. Applicator. The protection system applicator shall submit a satisfactory experience record including references for previous application of the specified protection system to concrete structures of similar design and complexity. The material manufacturer shall approve the applicator.

Submittals

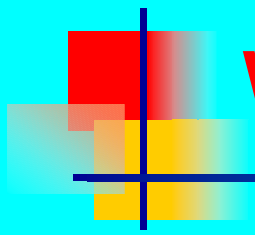
- Complete specifications and data of proposed system
- Application instructions and procedures
- Manufacturers approvals
- Certification of holiday free system

Submittals Paragraphs

1-3. SUBMITTALS. Complete specifications and data on the protection system, application instructions, and material manufacturer's approvals of the protection system furnished under this section shall be submitted in accordance with the submittals section. The protection system manufacturer shall provide certification for each component of the protection system that will provide corrosion resistance for the specified service conditions.

Submittals Paragraphs (cont.)

After application of the protection system, the material manufacturer shall certify the protection system is free of pinholes and holidays.



Warranty

- Manufacturers extended warranty
- Generally 3 to 5 years
- Longer warranties increase costs

Warranty Paragraph

1-5. WARRANTY. Material manufacturer shall warrant the chemical resistance of the corrosion protection system for a period of 3 years from the date of substantial completion when exposed to the customer's normal operating conditions as stated in the specification. This warranty does not cover wear and tear such as abrasion resistance or mechanical abuse.

Materials / Systems

- Suitable for expected service conditions
- Describe general components of system
- Indicate specific system components

Condition of Service Paragraph

2-1.01. Conditions of Service. The protection system shall provide splash and spill protection for 72 hours from the following chemical:

Sulfuric acid up to 98 percent concentration at a chemical temperature up to 150°F [65°C].

The lining will be exposed to sunlight and outdoor atmosphere.

Materials Paragraph

2.2. MATERIALS. Materials shall be suitable for the specified service conditions. Products composing the corrosion protection system shall be chemically resistant to the chemicals, concentrations, temperatures, exposure times, and other relevant service conditions.

Materials Paragraph (cont.)

In many cases, repair materials, primers, flexible basecoats, and other ancillary products will be protected by a corrosion resistant and/or wear resistant layer of the protection system and may not be required to meet these criteria provided the overall protection system complies with the performance criteria.

Materials Paragraph (cont.)

Each product of the protection system that complies with the performance requirements shall be certified as such by the protection system manufacturer. A vapor barrier that is recommended by the lining manufacturer shall be applied to the concrete surface and shall be included as part of the corrosion protection system at no additional cost.

Materials Paragraph (cont.)

The corrosion protection system shall be a two-component, 100 percent solids, solvent-free, novolac vinyl ester resin, silica filled, high-build protective and waterproofing coating, xxxx. Concrete surface primer shall be an epoxy resin containing conductive fillers, 100 percent solids content, xxxx. The flexible basecoat shall be certified by the material manufacturer as capable of not less than 75 mils of differential movement without damaging the corrosion protection system.

Materials Paragraph (cont.)

The protection system shall include a chopped strand fiberglass mat reinforcement and saturant. Saturant for reinforcement shall be epoxy resin. Finish coats shall be a two-component, 100 percent solids, novolac epoxy resin.

Materials Paragraph (cont.)

Chemical resistant caulking/sealant shall be suitable for the specified service conditions and shall be as recommended, in writing, by the protection system material manufacturer.

Surface Preparation

- Surface profile, minimum
- Specify industry standards
- Adhesion testing

Concrete Surface Protection Paragraphs

3-1. SURFACE PREPARATION. All surfaces shall be free of objectionable substances and shall meet the manufacturer's recommendations for surface preparation. If the lining material manufacturer recommends any other surface preparation, it shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

Concrete Surface Protection Paragraphs (continued)

All surfaces shall be dry when coated and free from dirt, dust, sand, mud, oil, grease, rust, mill scale, and other objectionable substances. Oil and grease shall be completely removed as recommended by the material manufacturer before mechanical cleaning is started.

Concrete Surface Protection Paragraphs (continued)

Contractor shall prepare the concrete surfaces in accordance with SSPC-SP 13/NACE 6. Concrete surfaces shall be prepared until they are acceptable to the lining material manufacturer.

Concrete Surface Protection Paragraphs (continued)

Surface profile shall be 4 mils [100 µm] for a coating protection system and 22 mils [550 µm] for a lining protection system, but not less than 25 percent of the total dry film thickness specified for the corrosion protection system.

Concrete Surface Protection Paragraphs (continued)

New concrete shall be cured for at least 4 weeks before the protection system is applied and shall be ready to receive the protection system as determined by the material manufacturer.

Concrete Surface Protection Paragraphs (continued)

Concrete surfaces shall be tested for capillary moisture migration in the concrete in accordance with ASTM D4263. There shall be no capillary moisture after 24 hours as indicated by the test method.

Concrete Surface Protection Paragraphs (continued)

If the manufacturer recommends using the calcium chloride test method, ASTM F1869, to test for capillary moisture migration in the concrete and the test results exceed 3 pounds/24 hours/1,000 square feet or more stringent conditions recommended by the lining manufacturer, the corrosion protection system shall include a vapor barrier that is recommended by the corrosion protection material manufacturer.

Concrete Surface Protection Paragraphs (continued)

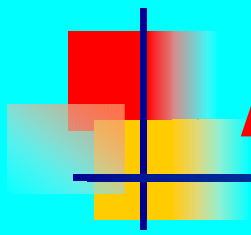
Adhesion testing shall be conducted as specified herein after the concrete surface has been prepare and approved by the material manufacturer. Adhesion strength test results shall exceed 500 psi [3.4 MPa] or a higher value if recommended by material manufacturer.

Concrete Surface Protection Paragraphs (continued)

All concrete surfaces to be lined shall be cleaned in accordance with ASTM D4258 and abrasive blasted in accordance with ASTM D4259. Before the protection system is applied, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. The Contractor shall repair all spalled areas, voids, and cracks and shall remove all fins and other surface projections to produce a flush surface for application of the protection system.

Concrete Surface Protection Paragraphs (continued)

Concrete surfaces, including those with bug holes less than 1 inch [25 mm] in any dimension, shall be prepared using an epoxy concrete filler or as recommended by the corrosion protection system material manufacturer.



Application

- Specific limitations
- As recommended by manufacturer

Application Paragraphs

3-3. APPLICATION. Corrosion protection system shall be applied in accordance with manufacturer's recommendations and in a neat manner, with finished surfaces free of runs, sags, ridges, laps, and brush marks. Corner protection and any other recommendations of the material manufacturer shall be provided. Grit shall be broadcast into first finish coat on the floor to produce an anti-skid surface.

Application Paragraphs (cont.)

Each coat shall be applied over the previous coat in accordance with the recommendations of the material manufacturer. Each coat shall be applied in a manner that will produce an even film of uniform and proper thickness. In no case shall coating be applied at a rate of coverage that is greater than the maximum rate recommended by the material manufacturer

Application Paragraphs (cont.)

Recoating shall be done in accordance with manufacturer's recommendations.

Alternate coats shall be of contrasting colors to facilitate in obtaining complete coverage. The first coat shall be of a dark color.

Application Paragraphs (cont.)

Protection system showing checks, blisters, excessive sags, teardrops, or fat edges will not be acceptable and shall be entirely removed and the surface recoated. The protection system shall be free of pinholes and holidays.

Application Paragraphs (cont.)

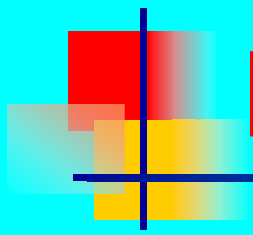
Corrosion resistant caulking/sealant shall be used at any penetration in the lining, such as at anchorage of pipe supports and chemical storage tanks.

Application Paragraphs (cont.)

Protection system shall be applied when surface temperature is 50°F or above and relative humidity is 90 percent or lower. Protection system shall not be applied in direct sunlight or when the temperature of the concrete is rising. Preferably the protection system shall be applied when the temperature of the concrete is dropping.

Temperature and Humidity Limitations Measurements

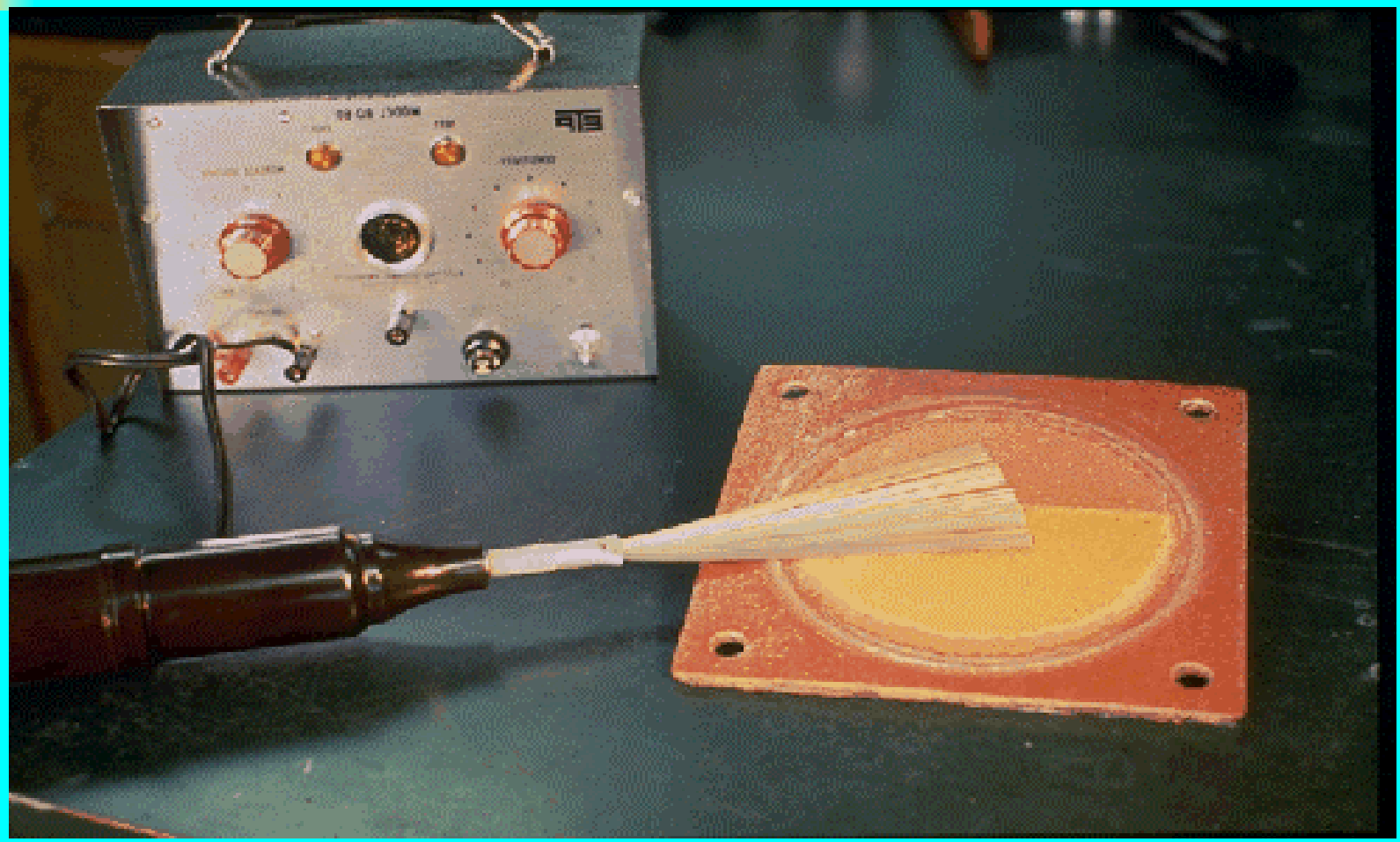
Application



Field Quality Control

- Visual inspection
- Spark Testing
- Adhesion testing

Spark Testing



In-Place Adhesion Testing

EVALUATION OF CONTRACTOR SUBMITTAL

- Evaluate proposed manufacturer
- Evaluate proposed protection system
- Determine compliance with specification
- Review for required submittals from the system material manufacturer

SUMMARY

- Make sure the Owner has the necessary protection system
- Make sure the system manufacturer takes the overall responsibility
- Make sure the Contractor and Applicator properly applies the system

CONCLUSION

Do it correct the first time every time.