**PART 1 – GENERAL**

1. Standard PVC use purple text.
2. PVC mesh use green text.

1. RELATED DOCUMENTS
2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections apply to the work of this section.
3. SUMMARY

A. This section includes an exterior architectural tensile membrane roof structure system.

1. The tensile membrane structure contractor (hereafter referred to as “Subcontractor”) shall be responsible for the structural design, detailing, fabrication, supply, and installation of the work specified herein, some or all of which may be contracted by Subcontractor to others meeting the qualification requirements of Section 1.5. The intent of this specification is to establish in the first instance an undivided, single-source responsibility of the Subcontractor for all of the foregoing functions.
2. Subcontractor’s work shall include, but not necessarily be limited to, the structural design, supply, fabrication, shipment, and erection of the following principal items:
3. The architectural membrane as indicated on the drawings and in these specifications.
4. Cables and end fittings.
5. Perimeter, catenary, and sectionalized aluminum clamping system.
6. Structural steel, including masts, trusses, struts, beams, and / or weldments, as indicated on the drawings.
7. Fasteners and gasketing.
8. The architectural membrane used in these structures shall be polyvinylchloride (“PVCwith Polyvinylidene Difluoride surface preparation (PVDF). All references to “membrane” in this section, without exception, and whether singular, plural, capitalized or not, are to such architectural membrane.
9. The architectural mesh membrane used in these structures shall be polyvinylchloride (PVC). All references to “membrane” in this Section, without exception, and whether singular, plural, or capitalized or not, are to such architectural membrane.
10. Related Sections:
11. 033000 – Cast-In-Place Concrete. (Are we providing 033000 spec?)

1.3 REFERENCES

1. General: Except as otherwise shown or noted, all work shall comply with the requirements of the following codes and standards:
2. American Institute of Steel Construction (AISC).
3. Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings
4. Code of Standard Practice for Steel Buildings and Bridges
5. Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design
6. Specification for Allowable Stress Design of Single-Angle Members
7. Seismic Provisions for Structural Steel Buildings
8. American Society of Civil Engineers (ASCE)
9. ASCE 19: Structural Applications of Steel Cables for Buildings
10. ASCE 7: Minimum Design Loads for Buildings and Other Structures
11. America Society of Testing and Materials (ASTM)
12. ASTM A 586: Standard Specification for Zinc-Coated Steel Structural Strand
13. ASTM A 603: Standard Specification for Zinc-Coated Steel Structural Wire Rope
14. ASTM A 780: Zinc Rich Paint Repairs
15. ASTM A 153: Hot Dip Galvanizing
16. ASTM D 751-00: Standard Test Methods for Coated Fabrics
17. ASTM E 84: Standard Test Methods for Coated Fabrics and Laminates
18. ASTM A 36: Carbon Steel
19. ASTM A 307: Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
20. ASTM E 84: Standard Test Method and Surface Burning Characteristics of Building Materials
21. ASTM 108: Standard Test Methods for Fire Tests of Roof Coverings
22. ASTM 136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750° C
23. ASTM C 423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
24. ASTM E 424: Standard Test Method for Solar Energy Transmittance and Reflectance of Sheet Materials
25. ASTM D 1117: Testing Non-Woven Fabrics
26. ASTM B 221-08: Standard Aluminum and Aluminum Alloy Extruded Bars
27. ASTM B 209: Standard Specification for Aluminum Sheet
28. America Welding Society (AWS)
29. AWS D1.1: Structural Welding Code
30. AWS 2.4: Symbols for Welding and Nondestructive Testing
31. Aluminum Association
32. Specifications for Aluminum Structures
33. National Fire Protection Association (NFPA)
34. NFPA 701: Standard Methods of Fire Tests for Flame Propagation of Textiles and Films
35. Steel Structures Painting Council (SSPC)
36. Steel Structures Painting Manual, Volumes 1 and 2

1.4 SYSTEM REQUIREMENTS

1. General: Provide a structural tensile membrane system that complies with requirements specified herein by testing the Subcontractor’s corresponding membrane system in accordance with the indicated test methods.
2. Building Code Criteria: The tensile membrane structure shall comply with the International Building Code, 2010 edition.

|  |  |  |
| --- | --- | --- |
|  | ***\*\*PLEASE NOTE ALL BELOW ITEMS WILL MEET IBC 2010 STANDARDS\*\**** |  |
| ● | Ground Snow Load: |  |
| ● | Snow Load Importance Factor: |  |
| ● | Roof Live Load: |  |
| ● | Basic Wind Speed: |  |
| ● | Wind Load Importance Factor: |  |
| ● | Wind Exposure Category: |  |
| ● | Seismic Use Group: |  |
| ● | Seismic Importance Factor: |  |
| ● | Mapped Spectral Response Acceleration at Short Periods, Ss: |  |
| ● | Mapped Spectral Response Acceleration at 1-Second Period, S1: |  |
| ● | Seismic Site Class: |  |
| ● | Damped Spectral Response Coefficient at Short Periods, Sds: |  |
| ● | Seismic Design Category: |  |

1. Life Safety: All tensile membrane structures shall be detailed so that no life safety issue is created in the event of a loss of a part of the membrane. The tensile membrane structure shall not rely on the membrane for structural stability.
2. The shade structures shall conform to all DSA requirements and the current adopted version of the California Building Code *2010* including DSA amendments and additions to the code and shall have a PC or an A number. (Only use if DSA)
3. Fire Performance: Range of characteristics required of membranes:
4. Burning Characteristics (NFPA 701)
5. Flame Spread (After Flame) Class C PASS
6. Flame Spread (Residual Flame) Class C PASS
7. Char length Class C PASS
8. Fire Resistance of Roof Coverings (ASTM E 108) (ASTM E 84)
9. Burning Brand – Small Scale Class C A PASS
10. Intermittent Flame Class C A PASS

1.5 QUALITY ASSURANCE

1. Subcontractor Qualifications: Fabrication and erection of the tensile membrane structure is limited to firms with proven experience in fabrication and construction of complex tensile membrane structures. Such firms, through their own experience and/or that of their qualified subcontractors, shall meet the following minimum requirements:
2. The Subcontractor shall have at least ten (10) years’ experience in the successful fabrication and erection of permanent, custom tensile mesh membrane structures.
3. The Subcontractor shall have fabricated and erected at least twenty (20) PVC/PVDF-coated woven fiberglass tensile mesh membrane structures, with at least five (5) structures of similar size and complexity as this project.
4. Demonstrate it has maintained an in-house professional engineering design staff for at least ten (10) years, and will provide final engineering drawings that have been prepared by licensed Professional Engineers in its employ.
5. The Subcontractor shall demonstrate it has a fabrication facility of adequate capacity and a staff experienced in the fabrication of PVC/PVDF-Coated polyester tensile mesh membrane structures that will undertake the fabrication of this project.
6. The Subcontractor shall submit a Corporate Quality Control Manual describing the company’s complete quality assurance program.
7. All bidders will need to provide a Payment & Performance Bond. The bidder needs to provide proof of a minimum bonding capacity of $13,000,000 by providing a signed letter from their surety company with their bid.
8. All bidders shall be able to provide proof with their bid of a minimum of $2,000,000 general/public liability insurance, $3,000,000 professional liability (PL) insurance and additional $10,000,000 umbrella/excess liability insurance.
9. All bidders must provide a signed letter with their bid from their legal representative stating that they are not or have not been in litigation with Owners, Contractors or A/E firms for failed structures within the past ten (10) years.
10. The Subcontractor must demonstrate their company’s steel fabrication capability by submitting a copy of their IAS Approved Fabricator Status. This is to be provided directly by the Subcontractor and Outside third party fabricators will not be accepted. (Use only if steel will be fabricated at SMI.)

1.6 SUBMITTALS

1. Submit under provision of Section 013300 – Submittal Procedures.
2. General: Not withstanding any provisions of these specifications that may appear to be to the contrary, any and all submittals by the Subcontractor shall be subject to review, approval, and adoption by the Architect/Engineer as part of the overall project design and engineering, and shall not create a contractual or other professional design relationship between the Subcontractor and either the Architect/Engineer or the Owner.
3. Product Data: Include manufacturer’s specifications for materials, fabrication, installation, and recommendations for maintenance. Include test reports showing compliance with project requirements where test method is indicated.

*Sample: Submit selection and verification samples.*

1. Design Drawings: Subcontractor shall submit tensile membrane structure drawings defining the completed structure, anchorage, and connection details, interfaces with building construction and general membrane seam arrangements. Design Drawings are to be signed and sealed by a Choose an item. Engineer in the State of Click here to enter text..
2. Design Calculations: Subcontractor shall submit complete calculations for the tensile membrane structure, as one package with the design drawings, signed and sealed by a Choose an item. Engineer licensed in the State of Click here to enter text.. Structural calculations shall include all required loading cases and load combinations used in the design and resulting member forces, reactions, deflections and drift. The magnitude of maximum reactions on the supporting structures from all critical load combinations shall be separately tabulated. Critical load conditions used in the final sizing of the members shall be emphasized. The design analysis shall include the name and office phone number of the designer to answer questions during the design drawing review.
3. Quality Assurance Submittals
4. Test Reports: Provide test reports from a qualified testing laboratory that show compliance of the Subcontractor’s PVC/PVDF-coated polyester mesh tensile membrane system with specification requirements, as follows:
5. Physical test data of the actual fabric roll goods to be used in the project confirming conformance with specifications for the membrane.
6. Certificates: Product certificates signed by the Subcontractor certifying materials comply with specified characteristics, criteria, and physical requirements.
7. See Section – 17000 – Close-out Procedures: Submit the following items:
8. Warranty: Project Warranty documents as described herein.
9. Record Documents: Project record documents for installed materials in accordance with Contract Conditions and Division 1 Submittal Procedures Section.
10. Maintenance Manual: Submit one (1) copy of a maintenance manual for the tensile membrane structure to the owner. The manual shall include a schedule for routine inspection, and inspection checklist, instructions for emergency repair and use of emergency repair materials, and warranty. During the system erection period, the owner shall provide maintenance personnel to be trained in the se of repair materials.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

1. See Section – 016000 – Product Requirements.
2. Materials shall be packed, loaded, shipped, unloaded, stored, and protected in a manner that will avoid abuse, damage, and defacement.

1.8 WARRANTY

1. The Subcontractor shall furnish the Owner with a written warranty, which warrants the membrane, its perimeter attachment system, and the structural support system as supplied by the Subcontractor have been installed in accordance with the project specifications and will be free from defects in materials and workmanship that will impair their normal use of service. The warranty shall start from the date of substantial completion of the tensile membrane structure; which shall be the first date on which the entire tensile membrane structure is subject to design pre-stress conditions.
2. One (1) year workmanship warranty on installed products

Ten (10) year structural warranty on structural steel and cables

One (1) year warranty on paint system

Manufacturer’s standard pass thru warranty on fabric

**PART 2 – MATERIALS**

2.1 QUALIFIED CONTRACTOR

1. *PFEIFER Structures*

ATTN: Click here to enter text.

1011 Regal Row

Dallas, TX 75247

Tel: Click here to enter text.

Fax: Click here to enter text.

1. Or approved equal. Substitution requests must be submitted by a prime bidder a minimum of ten (10) days prior to bid date. Any approved equals shall be issued by addendum only, prior to the bid date.
2. Approved bidders must meet all qualifications in Section 1.5 – Quality Assurance and show written proof for each item listed to become an approved equal.

2.2 ARCHITECTURAL MEMBRANE

1. General: The mesh membrane used in these structures shall be polyvinylchloride (PVC) with Polyvinylidene Difluoride (PVDF) top surface coating. All references to “membrane” in this section, without exception, and whether singular, plural, or capitalized or not, are to such architectural membrane.
2. The membrane shall meet the following general requirements:
3. Source Quality Control: The primary materials shall be obtained from a single manufacturer. Secondary materials shall be those recommended by the primary manufacturer.
4. Physical Characteristics: The following indicates a range of physical property types for PVC/PVDF architectural membranes. The determination of specific characteristics and selection of a membrane shall be derived from analysis and calculations carried out by the Professional Engineer for this project.
5. Construction: PVC/PVDF top coated Polyester with a PVC/PVDF blended bottom side
6. Coated Fabric Weight (oz./sq.yd): 22-24 11-12 oz. per sq yd

(ASTM D 751-00)

1. Thickness (mils) 20-45 16-18 nom.

(ASTM D 751-00)

1. Strip Tensile (lbs./1.968 inch, avg.)
2. Dry, Warp (ASTM D 751-00) 323-1,250 517-697 min. avg.
3. Dry, Fill (ASTM D 751-00) 310-950 360-472 min. avg.
4. Trapezoidal Tear (lbs./1.968 avg.)
5. Dry, Warp (ASTM D 751-00) 40-240 90-101 min. – 95 min. avg.
6. Dry, Fill (ASTM 4851) 30-200 45 min. – 120 min. avg.
7. Solar Transmission (%) (ASTM 424) 6 – 14 nom.
8. Solar Reflectance (%) (ASTM 424) 70 – 78 nom.
9. Flame Retardancy (NFPA 701) Complies – Small Scale
10. Color: White
11. Materials base fabric and coatings:
12. Yarns: The yarns used in the base fabric shall be high tenacity polyester of the highest commercial quality, essentially free of broken fibers after the weaving process, and fully suitable for coating. The fabric shall be woven with uniform tension and crimp in the warp and fill yarns and free of defects deleterious to the coating process. The base fabric shall be of sufficient width to allow for finished coated goods of at least 70 inches.
13. Weave: The weave shall be plain weave, panama weave, or malimou weave. The weave shall be uniform, with the warp and fill at right angles to each other with a tolerance of 5 degrees. The bow in the fill direction shall not exceed 1 inch or 1 in 30 offset to width over length.
14. PVC Coating: After weaving, the base fabric shall be cleaned and primed to achieve optimum mechanical properties of the coated fabric. The PVC coating shall consist of new PVC resin, plasticizers, UV inhibitors, mold inhibitors, flame retarding agents, and extenders. These materials shall be applied to form a weatherized barrier between the polyester yarns and the environment. The formulation shall be demonstrated to have given satisfactory performance in the past with regard to flexibility in handling, adhesion, and durability in use. The coating shall be applied evenly to both sides of the fabric and shall be of sufficient thickness to permit proper high frequency (HF) welding of joints.
15. Top Coating: To achieve a completely uniform surface with no discontinuities, spots, or lumps that would be objectionable to the unaided eye from a distance of fifteen (15) feet, either one of the following surface-top and bottom coats, PVC-coated polyester architectural mesh fabrics may be supplied:
16. PVDF Topcoat: Shall have a non weldable grafted Kynar® (i.e. polyvinylidene fluoride or PVDF) surface topcoat.
17. Weldable: PVC / PVDF blended top coat. **(use only for S top)**
18. Product Substitutions: No substitutions will be permitted.

2.3 CABLE AND END FITTINGS

1. Materials
2. All structural wire rope cables shall conform to the latest revision of ASTM A 603.
3. All structural strand cables shall conform to the latest revision of ASTM A 586.
4. All cables shall be coated to “Class A” zinc coating throughout.
5. Fabrication
6. Cable fabricator shall provide effective quality control over all fabrication activities. Inspection of the place of fabrication may occur at any time to verify proper quality control. This inspection does not relieve the fabricator from meeting the requirements of this specification.
7. Cables that are designated to be pre-stretched shall be pre-stretched per ASTM A 603 for wire rope and ASTM A 586 for structural strand. Cables of the same type shall have the same modulus of elasticity.
8. All cables shall be manufactured to the following length tolerances at 70° Fahrenheit (23° Celsius):
9. Length < 70 feet (213 meters) ¼ inch (6.4mm)
10. Length 70 to 270 feet (32.3 to 82.3 meters) 0.03% of length
11. Length > 270 feet (82.3 meters) 1 inch (25.4 mm)
12. Cables shall have a continuous longitudinal paint stripe (1/8 inch wide max.) along their top surface unless noted otherwise.
13. Index markings shown shall be a circumferential paint stripe (1/8 inch wide max.).
14. All cables and end fittings shall be delivered clean and dry.
15. All swaged and speltered fittings shall be designed and attached to develop the full breaking strength of the cable. Thimble end fittings shall develop a minimum of 90 percent of the cable breaking strength.
16. Swaged end fittings, pins, nuts, and washers shall be electro-galvanized. Any damage to the zinc coating shall be cleaned and painted with gray zinc-rich paint per ASTM A 780.
17. Speltered end fittings shall be hot dip galvanized per ASTM A 153. Any damage to the zinc coating shall be cleaned and painted with a gray zinc-rich paint per ASTM A 780.

2.4 ALUMINUM CLAMPING SYSTEM

1. Materials
2. All structural aluminum clamping systems shall be ASTM alloy 6061-T6.
3. Bent Plates shall be formed from ASTM B 221-08 alloy 6061 and then heat-treated to T6.
4. All structural “U straps” shall be ASTM B 221-08 Aluminum Alloy 6063, heat-treated to T5.
5. All structural aluminum clamping shall have the following finish:
6. Polyester thermosetting powder coating with a tri-glycidyl di-isocyanurate (i.e. TGDI) curing agent/hardener per American Architectural Manufacturers Association (AAMA) 603 to a thickness of 3 mils, whit in color

*OR*

1. Clear anodized per MIL-A 8625C, Type 2, Class 1.
2. Structural sheet aluminum shall be ASTM B 209 alloy 5052-H32.
3. Non-structural sheet aluminum shall be ASTM B 209 alloy 1100 series.
4. Fabrication
5. Aluminum fabricator shall provide effective quality control over all fabrication activities. Inspection of the place of fabrication may occur any time to verify proper quality control. This inspection does not relieve the fabricator from meeting requirements of this specification.
6. Fabricated aluminum shall have no sharp edges.
7. Stamp all parts with the appropriate mark number.
8. All fabricated aluminum shall be free of oil, grease, and machining chips.
9. Tolerances shall be as follows:
10. Cross sectional dimensions +/- 10%, 0.03 in. (0.8 mm) max.
11. Bolt hold locations +/- 1/32 in. (0.8 mm)
12. Overall length +/- 1/16 in. (1.6 mm)
13. All welded joints shall conform to AWS D1.2.

2.5 STRUCTURAL STEEL

1. General: The structural steel fabrication shall comply with the latest revision of all applicable codes, standards and regulations including the following:
2. ASTM (as referenced)
3. AISC: “Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings” and “Code of Standard Practice for Steel Buildings and Bridges”
4. SSPC: “Steel Structures Painting Manual, Volumes 1 and 2”
5. Research Council on Riveted and Bolted Structural Joints: “Specification for Structural Joints Using ASTM A 325 or A 490 Bolts”
6. AWS D1.1 and AWS A2.4
7. In the event of conflict between pertinent codes and regulations and the requirements of the references standards or these specifications, the provisions of the more stringent shall govern.
8. Submittals
9. General: Submit the following under provisions of Section 013300 – Submittal Procedures.
10. Shop Drawings:
11. The structural steel fabricator shall submit shop drawings to the Subcontractor for approval.
12. The drawings shall show all shop and erection details including cuts, copes, connection holes, threaded fasteners, bolts, stands and spacing, etc.
13. The drawings shall show all welds, both shop and field, by the currently recommended symbols of the AWS.
14. A welding procedure must be submitted to the Subcontractor for approval of welds that are not pre-qualified.
15. Shop drawings shall be carefully checked before being submitted for approval, and shall be submitted in the order in which they are needed for the executive of the work, well in advance and not all at one time. Submitted drawings shall show all structural steel required for the work, whether or not indicated on the drawings.
16. The fabricator shall not fabricate any material until after receipt of approved shop drawings.
17. The fabricator shall immediately make all corrections to his drawings as required by the Subcontractor and shall keep a satisfactory history of all changes by separately numbered and dated revision block on a convenient portion of each drawing affected.
18. Certification of material conformance that includes chemical and physical properties for all structural elements shall be submitted to the Subcontractor.
19. Materials
20. Structural steel for plates and bars shall conform to the requirements of ASTM A 36 or ASTM A 572, Grade 50, unless noted otherwise.
21. Structural pipe shall conform to ASTM A 53, Types E or S, Grade B.
22. Structural tubing shall conform to ASTM A 50, Grade B or C.
23. Structural bolts
24. High strength bolts: ASTM A 325, unless noted otherwise
25. Common bolts and nuts: ASTM A 307
26. Threaded rods: ASTM A 36, unless noted otherwise
27. Other materials: All other materials, not specifically described but required for a complete and proper installation of structural steel, shall be provided and shall be new, free from rust, first quality of their respective kinds, and subject to the approval of the Subcontractor.
28. Accessories
29. Base Plates and Anchor Bolts
30. Base plates supported on concrete, whether shop attached or shipped loose, shall be furnished and set on shims or leveling plates. Grouting shall be by the General Contractor.
31. Anchor bolt locations shall be furnished by the Subcontractor and used by the General Contractor to set the bolts. The General Contractor is to check carefully the setting of the bolts to their proper position prior to pouring of concrete. Anchor bolts, provided by the General Contractor, shall have two (2) nuts and washers. Damaged threads shall be repaired or be cut to permit full tightening of nuts.
32. Fabrication
33. Workmanship: All members when finished shall be true and free of twists, bends, and open joints between the components parts. Members shall be thoroughly straightened in the shop by methods that will not injure them, before being worked on in any way.
34. Properly mark materials, and match-mark when directed by the Subcontractor, for field assembly.
35. Connections:
36. Connections shall be as indicated on the drawings. When details are not shown the connections shall conform to the requirements of the AISC.
37. Provide high-strength threaded fasteners for all structural steel bolted connections, unless noted otherwise.
38. Combination of bolts and welds in the same connection are not permitted, unless otherwise detailed.
39. Welded Connections
40. Definitions: All terms herein relating to the welds, welding and oxygen cutting shall be construed in accordance with the latest revision of “Standard Definitions of Welding Terms and Master Chart of Welding Processes” of the AWS.
41. Operators: only operators who have been previously qualified by tests, as prescribed in AWS D1.1 to perform the type of work required shall make Welds.
42. Welding equipment shall be of sufficient capacity and maintained in good working condition, capable of adjustment in full range of current settings. Welding cables shall be adequate size for the currents involved and ground methods shall be such as to insure proper machine operation.
43. No welding shall begin until joint elements are clamped in proper alignment and adjusted to dimensions shown on the drawings and allowance for any weld shrinkage that is expected. No members are to be spliced without prior approval.
44. All welding shall be done in accordance with the reference specifications, with the following modifications and additions:
45. All field welding shall be done by manual shielded metal-arc welding.
46. All groove welds shall have complete penetration, unless otherwise specified on the drawings.
47. The minimum preheat and inter-pass temperature requirements shall be as required per AWS D1.1.
48. Welding Sequence: Heavy sections and those having a high degree of restraint must be welded in a sequence with the proper preheat and post-weld heat treatment such that no permanent distortion occurs. Submit a welding sequence for approval for these types of connections.
49. Oxygen Cutting: Manual oxygen cutting shall be done only with a mechanically guided torch. Alternatively, an unguided torch may be used provided the cut is not within ½ inch of the finished dimension and the final removal is completed by chipping or grinding to produce a surface quality equal to that of the base metal edges. The use of oxygen-cut holes for bolted connections will under no circumstances be permitted and violation of this clause will be sufficient cause for the rejection of any pieces in which oxygen-cut holes exist.
50. Tolerances: All tolerances shall be as per the AISC “Code of Standard Practice for Steel Buildings and Bridges”.
51. Paint System, Two-Part:
52. Source Quality Control: Primary materials shall be obtained from a single manufacturer. Second materials shall be those recommended by the primary manufacturer.
53. Surface Preparation and Base Coat
54. The surface shall be commercial blast cleaned in conformance with SSPC-SP10/NANCE 2, after all fabrication operations such as machining and welding are completed. There shall be no more than an eight hour time lapse between the surface preparation and the application of the primate coat.
55. The base coat shall be Sherman Williams Macropoxy 646 PW color mil white or light blue or approved equal, and shall conform to SSPC-Paint 22.
56. The base coat shall be mixed and applied in accordance with the manufacturer’s instructions and shall meet the requirements of SSPC Paint Specification No. 22. The minimum thickness shall be 2.0 to 4.0 mils dft.
57. Finish Coat
58. The finish coat shall be Sherman Williams Hi-Solid Polyurethane (semi-gloss) or approved equal, and shall conform to SSPC-paint number 36, level 3.
59. The finish coat shall be mixed and applied in accordance with the manufacturer’s instructions and the minimum thickness shall be 3.0 to 4.0 mils dft.
60. Two-Part System Thickness: The minimum system thickness shall be 8.0 mils dft.
61. Color: The paint color shall be as selected by the Architect
62. Finish Quality: The dry paint shall be uniform and continuous with no voids or puddles and shall not be broken by scratches or nicks. Although the Subcontractor’s Quality Assurance personnel may witness the painting operation, this does not relieve the painting subcontractor of the responsibility for meeting the quality and workmanship requirements of these specifications.
63. Care and Handling: The painting subcontractor shall make every reasonable effort to ensure that the painted steel is thoroughly dry and that it is handled carefully to prevent damage to the paint and to reduce field repairs. Nylon slings should be used when handling the painted steel.
64. Certification: The painting subcontractor shall be required to certify the paint manufacturer’s name, paint identification, conformance with manufacturer’s written instructions and the paint dry mil thickness.
65. Paint System, Three-Part:
66. Source Quality Control: Primary materials shall be obtained from a single manufacturer. Second materials shall be those recommended by the primary manufacturer.
67. Surface Preparation and Base Coat
	1. The surface shall be commercial blast cleaned in conformance with SSPC-SP10, after all fabrication operations such as machining and welding are completed. There shall be no more than an eight hour time lapse between the surface preparation and the application of the primate coat.
	2. The base coat shall be Sherman Williams inorganic zinc rich coating (zinc clad II ethyl silicate). Color gray-green or approved equal and shall conform to SSPC-Paint 20.
	3. The primer shall be mixed and applied in accordance with the manufacturer’s instructions and shall meet the requirements of SSPC Paint Specification No. 20. The minimum thickness shall be 2.0 to 4.0 mils dft.
68. Intermediate Coat
69. The intermediate coat shall be Sherman Williams Macropoxy 646 fast cure epoxy color Mil white or light blue or approved equal and shall conform to SSPC Paint Specification 22.
70. The surface preparation is to conform to SSPC-SP10/NANCE 2.
71. The intermediate coat shall be applied in accordance with the manufacturer’s instructions. The minimum thickness shall be 4.0 – 6.0 mils dft.
72. Finish Coat
73. The finish coat shall be Sherman Williams Hi-Solid Polyurethane (semi-gloss), or approved equal, and shall conform to SSPC – Paint number 36, Level 3.
74. The finish coat shall be mixed and applied in accordance with the manufacturer’s instructions and the minimum thickness shall be 3.0 to 4.0 mils dft.
75. Three-Part System Thickness: The minimum system thickness shall be 10.0 mils dft.
76. Color: The paint color shall be as selected by the Architect.
77. Finish Quality: The dry paint shall be uniform and continuous with no voids or puddles and shall not be broken by scratches or nicks. Although the Subcontractor’s Quality Assurance personnel may witness the painting operation, this does not relieve the Painting Subcontractor of the responsibility for meeting the quality and workmanship requirements of these specifications.
78. Care and Handling: The painting subcontractor shall make every reasonable effort to ensure that the painted steel is thoroughly dry and that it is handled carefully to prevent damage to the paint and to reduce field repairs. Nylon slings should be used when handling the painted steel.
79. Certification: The painting subcontractor shall be required to certify the paint manufacturer’s name, paint identification, conformance with manufacturer’s written instructions, and the paint dry mil thickness.
80. Powder Coating
81. Galvanized steel tubing preparation prior to powder coating shall be executed in accordance to solvent cleaning SSPC-SP1. Solvents such as industrial thinner are to be used to remove foreign matter from the surface. Power Tool Cleaning SSPC-SP3 will be performed prior to any solvent cleaning preparation; utilizing wire brushes abrasive wheels and needle gun, etc.
82. Carbon structural steel tubing preparations prior to powder coating shall be executed in accordance to commercial blast cleaning SSPC-SP5 or NACE #1. A commercial blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, mill scale, rust, coating, oxides, corrosion, products and other foreign material.
83. Powder coating shall be sufficiently applied with a minimum 2.5 – 3 mils thickness and cured at the manufacturer’s specified temperature to provide proper adhesion and stability to meet salt spray and adhesion tests as defined by the American Society of Testing Materials (ASTM).
84. Powder utilized in the powder coat process shall have the following characteristics:
85. Specific Gravity: 1.2 – 1.8
86. Coverage at 1.0 Mil: 110 – 160 ft2/lb
87. Mass loss during cure: <1%
88. Maximum storage temperature: 80o F
89. Rust protection under powder coat primer will be required on all structures in high humidity and salt content areas. Powdura® Epoxy Powder Coating Z.R Primer shall be applied in accordance with the manufacturer’s specifications. Primer is to be fused only, then top coated with the selected powder coat to ensure proper inter-coat adhesion.

*The Epoxy Powder Coating Primer Characteristics:*

1. *Adhesion (ASTM D 3359) 5B*
2. *Flexibility (ASTM D 552) Pass 1/8” Mandrel Bend*
3. *Pencil Hardness (ASTM D 3363) H-2H*
4. *Impact Resistance (ASTM D 2794) 20-160 Dir/Rev*
5. *Salt Spray Resistance (ASTM B 117) 2000 hours*
6. *Humidity Resistance (ASTM D 4585) 2000 hours*
7. *60o Gloss: 20.0 – 100.0%*
8. *Cure Schedule (metal temp): 10 min at 400o F*
9. *Film Thickness Range: 3.0 – 4.0 mils*

***Above in blue for coastal primer only\*\*\****

1. Source Quality Control:
2. Testing
3. An independent testing laboratory paid for by the owner shall perform testing and inspection of the structural steel and welding. All welds shall be tested by visual, dye penetrant, magnetic particle methods in accordance with instructions from the Subcontractor.
4. The Subcontractor and the testing laboratory inspector shall be permitted to inspect the work in the shop or field throughout fabrication and erection.
5. The inspector shall check for workmanship of steel, both in the shop and field, and check general compliance with the contract documents and steel shop drawings. The inspector shall record types and locations of all defects found in the work and measures required and performed to correct such defects.
6. The steel fabricator shall make all repairs to defective work to the satisfaction of the inspector and at no additional cost to the Subcontractor.
7. The inspector shall submit reports of his inspection and test findings to the Subcontractor. He shall record all defects found with the subsequent repair operations and submit reports to the Subcontractor.
8. The work of the independent inspector shall in no way relieve the steel fabricator of his responsibility to comply with all requirements of the contract documents.
9. Product Handling and Protection: Use all means necessary to protect structural steel before, during, and after installation, and to protect the installed work and materials of all other trades.
10. Rejection and Replacement:
11. In the event of damage to the steel, immediately make all repairs and replacements necessary to the approval of, and at no additional cost, to the Subcontractor.
12. Any materials or welding rejected through inspection either in the shop, mill, or field must be promptly replaced to the satisfaction of, and at no additional cost to, the Subcontractor.
13. Qualifications of Steel Fabricator: The steel fabricator shall have not less than five (5) years continuous experience in the fabrication of structural steel.

2.6 FASTENERS

1. General: Provide fasteners used to secure clamp systems to curbs and cables, assemblage of clamp systems, and other fasteners as required to complete the work specified herein.
2. Materials:
3. All work shall comply with the latest edition of ASTM standards and American Iron and Steel Institute (AISI), as referenced herein.
4. Fasteners used in membrane clamping systems shall be stainless steel. Bolts and studs shall conform to ASTM F 593, type 304. Nuts shall conform to ASTM F 594, Type 316. Washers shall be plain, narrow, and conform to AISI Type 18-8.
5. All clamping systems subjected to relative movement between clamping and curb shall receive a split-ring lock washer conforming to AISI Type 18-8.
6. Unless otherwise specified on the drawings, all other bolts and nuts shall conform to ASTM A 307-76B, zinc plated to conform to ASTM B 633 Class FE/ZN 8 type III.
7. Source Quality Control: The manufacturer shall certify that all fasteners comply with the above referenced specifications.

2.7 GASKETING

1. General: All work shall comply with the latest edition of ASTM standards, as referenced herein.
2. Sponge Neoprene Gasketing:
3. Material
4. All sponge neoprene shall be of a cellular elastomeric compound of a firm grade, which has been manufactured in pre-formed shapes for use as gasket and sealing material, as specified in ASTM specification C 509.
5. Cellular elastomeric materials furnished to this specification shall be manufactured from natural or synthetic rubber, or mixtures of these, with added compounds of such nature and quality that, with proper curing, the finished product will comply with this specification.
6. The cured compounds shall be suitable for use where resistance to sunlight, weathering oxidation and permanent deformation under load are of prime importance.
7. The manufacturing process shall be such as will ensure a homogeneous cellular material free of defects that may affect serviceability.
8. The physical characteristics of the neoprene musht meet or excess ASTM C 509, “Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Materials.”
9. Certification of material shall be provided that conforms to ASTM C 509.
10. Dense Neoprene Gasketing:
11. All neoprene material shall conform to ASTM D 2000M hardness Grade 60. The material shall be homogenous, free from defects and shall be compounded and cured to meet the requirements specified herein.
12. All neoprene shall be non-staining formulation and shall consist of at least 50 percent by weight of basic rubber hydrocarbon. Material shall not contain crude or reclaimed rubber.
13. The physical characteristics of the neoprene must meet or exceed the following physical test requirements when tested using the standard ASTM test slab can compression set plug (or approved equal):

|  |  |  |  |
| --- | --- | --- | --- |
|  | **PROPERTY** | **ASTM METHOD** | **UNITS** |
| a. | Shore A Durometer | D2240 | 55-65 |
| b. | Tensile Strength (Min.) | D 412 | 1,100 psi |
| c. | Percent Elongation (Min.) | D 412 | 300% |
| d. | Percent Compression Set (Max.) | D395, Method B, 22hrs at 212o F | 35% |
| e. | Heat Aging, Change from original properties: |  |  |
|  | ● Hardness Change (Max.) | +15 Points Shore A |  |
|  | ● Tensile Strength (Max.) |  | -15% |
|  | ● Elongation Change (Max.) | -40% |  |
| f. | Flame Resistance |  | Must not propogate flame |
| g. | Temperature Range |  | -30oC to -100oC |
| h. | Ozone Resistance | D1171, Method A, 72 hrs @ 38oC and 50 mPa Ozone |  |
| i. | Resistance to Oil Aging: | D471, 70hrs @ 212oF Immersion in ASTM Oil No.3 |  |
|  | ● Tensile Strength (Max.) |  | -70% |
|  | ● Elongation (Max.) |  | -55% |
|  | ● Volume Change (Max.) |  | +120% |

2.8 MAINTENANCE KIT

1. Architectural Membrane Maintenance Kit: The owner shall be supplied with the following materials for emergency repair or maintenance. The materials shall be neatly packaged into a maintenance kit for storage by the owner.

|  |  |  |
| --- | --- | --- |
|  | **QUANTITY** | **DESCRIPTION** |
| ● | 6 | 12” / 305mm diameter PVC outer membrane patch |
| ● | 12 | 5” / 127mm diameter outer membrane patch |
| ● | 12 | 4” x 8” / 102 x 204mm  |
| ● | 2 sq. yds. | Outer Membrane |
| ● | 1 | 2” / 50mm roller |
| ● | 1 | Hand held hot air sealer |
| ● | 1 | 5/8” / 16mm hole punch |
| ● | 1 | Utility knife |
| ● | 25 | Repair clips |
| ● | 1 | Spool of No. 36 x 8 oz. (268’) nylon twine |
| ● | 36 yds. | Cormar B29/4 x 15 Kevlar® thread |
| ● | 1 | Hand awl |
| ● | 1 pkg. | C-29 curved needles |
| ● | 1 | Repair manual |

**PART 3 – FABRICATION AND ERECTION**

3.1 FABRICATION OF MEMBRANE PANELS

1. General
2. Membrane assembly design drawings shall include all information necessary for the fabrication by the Subcontractor of the tensile membrane structure. They shall include size and shape of envelope, type, and location of shop and field connections, size, type and extent of all radio / high frequency (RF/HF) seams.
3. The Subcontractor shall take necessary care to plan and assemble the fabricated sections such that the assembly has not shop patches. Splices, if any, shall be patterned into a symmetrical and repetitive geometric arrangement within the assembly, shown on the design drawings and, where feasible, hidden by structural members.
4. All fabricated joints shall have a minimum of 90 percent of the total strength of the coated membrane in strip tensile testing. All structural joints shall be fused in accordance with industry standards and shall maintain the integrity of the coating. PVC/PVDF-coated polyester membranes shall be RF/HF seamed only.
5. Biaxial Test: At least one (1) representative sample of the outer membrane shall be biaxially test loaded. Membrane compensation in patterning shall be based upon results of the biaxial test loading.

3.2 ERECTION OF MEMBRANE ASSEMBLIES

1. Prior installation of the membrane assemblies, the Subcontractor shall meet with the General Contractor to review the erection procedure and scheduling. The Subcontractor shall coordinate all work with other trades.
2. No trade shall have access to, or work from the membrane, unless authorized by the Subcontractor in writing.
3. Erection of structural steel
4. The Subcontractor shall employ a competent foreman to supervise all work of steel erection. This foreman shall be present at all times during the Subcontractor’s scope of work.
5. All precautions shall be taken to ensure an accurately located and completely safe and stable structure at all times. Adequate guy cables shall be used throughout the work and all erection bolts shall be drawn up tight.
6. All steel shall be accurately aligned before permanent connections are made.
7. Temporary bracing shall be left in place as long as may be required for safety. The bracing shall be located so it does not interfere with the erection for the tensile membrane structure, and can be removed as required during construction.
8. The structure is to be self-supporting and stable after the structure is fully completed. It is the Subcontractor’s sole responsibility to determine the erection procedure and sequence and to ensure the safety of the structure and its component parts during erection. This includes the additional of whatever temporary bracing, guys or tie-downs that may be necessary. Such materials shall be removed by the Subcontractor and remain his property after completion of the property.
9. Erection tolerances shall be specified in the AISC “Code of Standard Practice for Steel Buildings and Bridges”, unless otherwise noted.

3.3 CLEANING

1. Protect work from damage and deterioration during installation.
2. Upon completion of tensile membrane structure installation:
3. The Subcontractor shall clean all surfaces of the system’s components in conformance with the membrane manufacturer’s recommendations.
4. Inspect the system and repair membrane panels that become damaged. Repairs shall be executed in such a way that they are visually acceptable.
5. Steel Cleaning:
6. Cleaning and touchup steel finishes field welds, bolted connections and abraded areas shall be completed per the manufacturer’s field repair recommendations.

**…** END OF SECTION **…**