

**SECTION 13125**  
**PRE-ENGINEERED MEMBRANE STRUCTURE**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes the design, engineering, fabrication and erection of a frame-supported, tensile-membrane structure complete with entrance and exit doors and associated hardware and all components necessary for a weather-tight enclosure. Work includes, but is not necessarily limited to, the following:
  - 1. Field verification and acceptance of existing conditions as suitable for installation.
  - 2. Coordination with the design team through preparation of drawings for approval and/or permit submittal.
  - 3. Preparation of documentation and engineering support for the design of foundation system.
  - 4. Submitting stamped/signed engineered drawings for permits and/or approvals.
  - 5. Coordination of submittals, installation, etc. with General Contractor or other project authority.
  
- B. Applicable Codes
  - 1. Building design shall comply with the applicable provisions of the 2006 edition of the International Building Code (IBC) and by reference, the American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures (ASCE7-02).
  - 2. Americans with Disabilities Act, Standards for Accessible Design.
  - 3. National Fire Protection Association, (NFPA) 701.

**1.2 SYSTEM DESCRIPTION**

- A. Frame Supported, Tensile Membrane Structure shall be a pre-engineered system of standard metal framing components and membrane enclosure designed to provide .... gross square feet of fully-enclosed space and shall include the following:
  - 1. Flat gable ends to maximize interior dimensions.
  - 2. The side, and end, wall construction shall accept passage and exit doors.
  - 3. Exterior membrane shall run continuous from eave to eave or base of structure to base of structure.
  - 4. Exterior membrane will be fabricated for post-installation tensioning in both primary grid directions; draped or loose-laid membrane installation is not acceptable.
  - 5. Exterior membrane will be colors selected by the Architect from Manufacturers' standard line.
  - 6. Exterior membrane shall, upon completion, provide a continuous weather-tight enclosure.
  - 7. Upon installation and tensioning of the exterior membrane it will be smooth and wrinkle-free and shall remain so under anticipated thermal and live-load conditions.
  - 8. Membrane shall be repairable without the need to dismantle any portion of the structural framing.
  - 9. Membrane shall be attached to framing that allows for ventilation fans or HVAC duct penetrations.
  
- B. Design Requirements
  - 1. Design the structure to be clear span, with no visible poles or columns inboard of the perimeter framing.
  - 2. Design the structure to be clear span, with no guy-ropes or cables extending or attaching perpendicular or at angles to the perimeter walls.

3. Design the structure so that there are no structural purlins, cables or other obstructions to flow of water or sliding snow on the exterior membrane.
  4. Design the structure to accept personnel doors at the locations indicated in the contract drawings.
  5. All doors and other penetrations shall have a separate frame to which the fabric membrane is attached. This frame shall be designed to support the prestress and maximum working loads of the fabric. These frames shall be designed in such a way that doors or other equipment inside them can be replaced without affecting the membrane tension.
  6. All column bases shall be designed as pin connected and shall not rely on moment capacity of the foundation for support.
- C. Structural Performance Requirements. Design the anchoring system, framing components, connections and composite structure following the applicable codes noted in Section 1.1.B and the requirements of the authorities having jurisdiction.
1. Design Codes
    - a. American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures, ASCE 7-02 Edition
    - b. American Institute of Steel Construction (AISC), Manual of Steel Construction, Allowable Stress Design, 9th Edition.
    - c. American Institute of Steel Construction (AISC), Manual of Steel Construction, Load and Resistance Factor Design, 2nd Edition, Volumes I and II.
    - d. American Welding Society (AWS), 1996 Structural Welding Code, Steel.
    - e. American Concrete Institute (ACI) ACI-318-95, Building Code Requirements for Reinforced Concrete.
    - f. American Iron and Steel Institute (AISI), Specification for the Design of Cold-Formed Steel Structural Members.
    - g. The Aluminum Association Aluminum Design Manual, Specifications and Guidelines for Aluminum Structures, edition 2005.
  2. Soils Report to be provided by Owner.
  3. Design Criteria
    - a. Basic Wind Speed; 90 mph – 3 second gust. (Can be adjusted to any other requirements)
    - b. Wind Exposure; C – Open Terrain
    - c. Wind Importance Factor; 1.0
    - d. Ground Snow Load; 30 pounds per square foot
    - e. Snow Importance Factor; 1.0
    - f. Seismic Requirements; per applicable Building Code.
  4. Design and engineer the structure so that no life-safety threat is created by the loss of any portion of either the interior or exterior membrane. The structural framing shall not rely on the tensioning of the exterior membrane for its stability or rigidity.
  5. Membrane shall be designed such that it meets the same load requirements as the structural frame. The developed membrane stresses must be applied to the structural frame. Minimum membrane safety factors shall be, for Allowable Stress Design (ASD):
    - a. 4, for Wind Load
    - b. 5, for Snow Load
    - c. 8, for Prestress + Dead Load

### 1.3 SUBMITTALS

- A. Submit for the Architect's and Owner's review.
  1. Product Data and samples for each prefabricated and commodity component.
  2. Erection Drawings by the Manufacturer's engineers, for components and erection of the structure.
    - a. Show piece marks that will be used on components delivered to the Site.

- b. Structural erection drawings, and calculations if applicable, shall be signed and sealed by a qualified structural engineer, registered in the State of Alaska\_.
  - 3. Color Selection Samples for the following; fabric samples shall be at least twelve inches square. Furnish three sets of samples plus the number desired to be returned.
    - a. Exterior membrane(s)
    - b. Interior liner membrane(s )
    - c. Framing member finishes (exterior and/or interior).
- B. Submit for the Owner's use / records.
  - 1. Certificates of Compliance regarding Fire Resistance Classifications of Materials.
  - 2. Extra Materials
  - 3. Executed Warranties
  - 4. Mill certificates for structural steel

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications
  - 1. Company with at least ten years experience in design, engineering, production and erection of fabric structures.
  - 2. Manufacturer shall employ at least one qualified engineer to produce or supervise the production of Shop and Erection Drawings.
  - 3. Manufacturer shall have completed at least ten projects of which at least five are now more than three years old; submit list with the names and telephone numbers of knowledgeable client contacts.
    - a. Site Representative, assigned to this Project, shall have supervised at least five projects within the past three years that are similar in scale and complexity to those required for this Project.
  - 4. Manufacturer shall have a current and comprehensive quality management system, encompassing at a minimum, the design, procurement, contracting, project management, and quality inspection functions. ISO 9001: 2000 is preferred, similar considered.
  - 5. If the Manufacturer's installation services are not required, the Manufacturer shall provide site supervision and basic training.
  - 6. If the Manufacturer's installation services are not required, the Manufacturer shall have a consultant or technician employed by the Manufacturer to provide the on-site observation and technical services required to assure proper installation of this work and, if needed, to validate its warranty.
- B. Installer's Qualifications if not the manufacturer.
  - 1. Installer shall have the level of experience necessary to install the products as determined by the manufacturer.
  - 2. Acceptable to or licensed by Manufacturer; certify that the members of the crew scheduled for this Project are familiar with the Manufacturer's product line.
  - 3. Company shall maintain and submit proof of all necessary insurance, including liability insurance, for its workers.
- C. Manufacturer's Engineers:
  - 1. Professional Engineers must be duly registered to practice their specialties in the State of Alaska with demonstrated experience designing and detailing systems for frame supported tensile-membrane structures.
- D. Material Qualifications
  - 1. Membrane shall have a minimum five year history as a successful commercial building enclosure system.
    - a. A failure is an alleged defect that prompts the Owner to seek remedy under the Manufacturer's Warranty (See Section 1.6.B).

2. Membranes shall be UL- or NFPA-rated flame resistant materials; submit copies of test reports from independent testing agency.
- E. Single Source Responsibility. Furnish complete assembly by or as recommended by a single company.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Packing and Shipping. Deliver products in suitable packaging with legible identification.
- B. Storage and Protection
1. Manufacturers' field representative or designee shall be present on-site to receive, off-load, and store safely/securely all supplied materials.
  2. Follow the manufacturer's recommendations.

## **1.6 WARRANTIES**

- A. Fabric Structure Warranty - The manufacturer shall provide a twelve year limited warranty, prorated based on the purchase price, for the membrane and a twenty-five year limited warranty on the frame against defects in material and workmanship under normal use and services.
- B. Accessory Warranty. The Manufacturer and/or Installer shall jointly warrant all provided accessories (including, but not limited to, ventilation system, doors, etc.) for a period of time equal to the published manufacturer's product warranty. Terms are to be "back-to-back" with this warranty.

## **1.7 MAINTENANCE**

- A. Extra Materials. Provide, as Extra Materials, a manufacturer's recommended maintenance kit. Kit shall contain membrane patches, roll-stock membrane accessories, sealing and bonding agents, and basic membrane specialty tools required to perform the emergency repairs demonstrated to the Owner's personnel under Part 3 of this Section.
1. Patching materials for membranes shall be from the same production run as materials installed.
  2. Deliver Extra Materials as directed by the Owner.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Manufacturers' standard system components, including membrane, aluminum or steel support structure, pedestrian doors, and all associated accessories and finishes necessary for a complete weather-tight building.
- B. Exterior Membrane: PVC-coated polyester scrim. Exterior membrane shall be fabricated of one type of translucent and/or opaque membrane, as indicated by the Architect.
1. Colors: Multiple colors may be utilized; to be selected by the Architect from the manufacturers' line of available colors.
  2. Exterior membrane to have self-cleaning properties
  3. Minimum weight of exterior membrane:
    - a. Translucent Fabric  $\pm 22$  oz/yd<sup>2</sup>
    - b. Opaque  $\pm 24$  oz/yd<sup>2</sup>

- C. Structural Steel
  - 1. Steel employed for exterior use is to be hot-dip galvanized or pregalvanized and painted. Pregalvanized material without full secondary protection is unacceptable for exterior use.
  - 2. Steel employed for interior use is to be hot-dip galvanized, pregalvanized and painted, or painted. Pregalvanized material without full secondary protection is unacceptable for interior use.
  - 3. Steel parts used as connectors in contact with aluminum shall be hot-dip galvanized.
  - 4. Other steel parts shall be either hot-dip galvanized, or pregalvanized and painted.
  - 5. Truss shall be solid steel angle cranked design. Tube steel is not acceptable.
  
- D. Cables: ASTM A603 wire rope or A586 structural strand cables; use only one type with one modulus of elasticity throughout the structure. Where used in contact with membrane, use PVC coated cables. Furnish with fittings designed to provide at least 90% of the full breaking strength of the cables.
  
- E. Steel: minimum per the standard below, or as needed per the structural design:
  - 1. Structural Steel Shapes, Plates, etc.      ASTM A36 or A992
  - 2. High Strength Bolts                            ASTM A325
  - 3. Anchor Bolts                                    ASTM A307 or A325
  - 4. Hollow Structural Sections                 ASTM A500, Grade B,  $F_y = 46$  ksi or equiv.
  - 5. Pipe    ASTM A53,  $F_y = 35$  ksi
  - 6. Reinforcing Steel                             ASTM A615,  $F_y = 60$  ksi
  - 7. Pins    ASTM A36 or A500

## 2.2 ACCESSORIES

- A. Fasteners, Bolts, Nuts: ASTM A123, G90 galvanized or zinc plated. Fasteners permanently exposed to outside environment shall be hot dip galvanized or stainless steel
- B. Exit Passage Doors: Manufacturer's Standard with code-compliant panic hardware. All doors are to have separate sub-frames (See Section 1.2 B.5)
- C. Lighting System: Provide system best suited to meet requirements for facility usage. Final requirements will be determined during final design phase after award of contract.
- D. Exterior Doors: Acceptable structure will allow single gable installation of three (3) 16'W clear x18'H clear roll-up cargo doors.

## 2.3 FABRICATION

- A. General. Components, upon completion, shall be true to line, free of twists, bends, misalignments with neatly finished welds.
  - 1. All welds that will be exposed to view shall be ground to a smooth aesthetic finish.
  - 2. Mark materials with the piece shown in the accepted Erection Drawings; locate marks so that they will be readily observable for delivery and installation inspections but concealed in the completed work. Loss or obscuring of piece marks prior to acceptance of their installation may be grounds for rejecting the related work.
  - 3. Overlap welds in the membrane that are perpendicular to the slope shall be tiled with the upper panel on top of the lower panel.
  - 4. Fabricate joints (seams and splices) in the membrane to develop at least 90% of the membrane's tensile strength. Use thermally fused (heat welded), or other methods recommended by the membrane manufacturer. Welded seams are to be tested at elevated temperatures prior to installation/erection.
  - 5. Membrane welding in the shop shall be subject to a quality procedure to ensure the quality of the welds, and the associated records shall be maintained for the project for a minimum period of five years.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify Conditions
  - 1. Examine areas and conditions, under which Work is to be performed, and identify conditions detrimental to proper or timely completion.
  - 2. Review preparatory work of others including the layout and anchor embedment locations if used.
  - 3. Do not proceed until unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION / ERECTION**

- A. Follow the manufacturer's recommendations, the accepted Erection Drawings and the documentation.
  - 1. Erect the structural frame, secure the exterior membrane and tension carefully following the manufacturer's instructions. Obtain minimum tension prestress values in membrane, and resultant stress values in the structural framing, and as required in order to maintain the profile of the structure under anticipated wind loads.
  - 2. Seal the exterior membrane, around door frames, ductwork and similar penetrations.
  - 3. Seal the exterior membrane around the structure perimeter.
  - 4. Install the liner membrane; coordinate with mechanical and electrical installations.
  - 5. Install doors and closures to maintain both the horizontal and vertical tension of the membrane.
- B. Erection Tolerances: as specified in the AISC Code of Standard Practice for Steel Buildings and Bridges

### **3.3 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Services. Manufacturer's Technical Representative shall provide the field observation and technical services during installation required to validate the specified warranties to include at least the following:
  - 1. Perform pre-installation examination and acceptance of preparatory work for each stage.
  - 2. Be present for each process. Confirm construction sequence and techniques.
  - 3. Upon completion, issue a final statement indicating manufacturer's acceptance of installed system together with a fully executed warranty.

### **3.4 DEMONSTRATIONS**

- A. At a time near Substantial Completion, and as mutually agreed, demonstrate the manufacturer's recommended routine inspection and emergency repair procedures to the Owner's personnel. Use materials and methods recommended by the structure manufacturer. Demonstrate uses and proper techniques for installing materials provided in the Maintenance and Repair Kit.

**END OF SECTION**