



SECTION 13 31 23

TENSIONED FABRIC SHADE STRUCTURES

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Current version: americanupholstery.com/specifications.html

EDITOR'S NOTE TO THE SPECIFIER

This is a three-part CSI guide specification for tensioned HDPE fabric shade structures, with American Upholstery of Phoenix, Arizona as the basis of design. Copy it into the project manual, choose or delete each bracketed option [like this], and coordinate the related sections listed in 1.2. The qualification, field-dimension and substitution requirements in Part 1 are performance requirements; keep them intact so that any proposed equivalent is held to the same standard as the basis of design.

Code basis: the 2021 International Building Code (IBC), the edition in effect in the most states; section numbers below are from that edition. Confirm the edition adopted by the authority having jurisdiction (AHJ). The City of Phoenix, for example, adopted the 2024 codes effective August 1, 2025.

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes design-assist, field measurement, fabrication and installation of tensioned HDPE fabric shade structures (shade sails), including membranes, perimeter cables, corner hardware, tensioning hardware, [steel posts, extensions and base plates,] and attachments to [new] [existing] supporting structure.

B. Single-source responsibility: membrane fabrication, hardware, [steel fabrication,] field measurement and installation shall be performed by one fabricator, or by a fabricator and installer under common ownership. Division of this work among unaffiliated firms is not permitted.

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete: footings.

B. Section 05 12 00 – Structural Steel Framing; Section 05 50 00 – Metal Fabrications: posts and supports not furnished under this section.

C. Section 09 96 00 – High-Performance Coatings: field touch-up of shop finishes.

1.3 REFERENCES

A. ASCE 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures, edition adopted by the authority having jurisdiction (AHJ).

B. AISC 360 – Specification for Structural Steel Buildings; AWS D1.1 – Structural Welding Code – Steel.

C. ASTM D5034 (grab tensile); ASTM D2261 (tongue tear); ASTM D6797 (ball burst); ASTM E84 (surface burning characteristics).

D. AS 4174:2018 – Synthetic shade fabric (UV and shade performance).

E. International Building Code (IBC), [2021] edition as adopted by the AHJ: Chapter 16 (Structural Design), Section 3102 (Membrane Structures), Section 3105 (Awnings and Canopies).

F. ASCE 55 – Tensile Membrane Structures (referenced by IBC 3102.2).

G. NFPA 701 – Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.4 DEFINITIONS

A. Field dimensions: straight-line, point-to-point measurements between the actual connection points of the membrane: every side, all diagonals, and the height of each connection point.

B. Membrane: the sewn fabric panel including edge pockets, perimeter cable and corner reinforcement.

C. Pretension: tension applied to the membrane at installation, before wind load.

D. Hypar: a four-or-more-point membrane with opposite corners at different heights, forming a hyperbolic paraboloid.

1.5 PERFORMANCE REQUIREMENTS

A. Delegated design: posts, footings, connections and attachments to supporting structure shall be designed by a structural engineer registered in the State of Arizona, retained by [the Contractor] [the Owner], and sealed drawings and calculations submitted for approval and to the AHJ.

B. Design loads: ASCE 7 wind loads for the site, plus membrane pretension and dead load. Treat membrane loads as dynamic: corner reactions change in magnitude and direction as the membrane deflects, and connections see repeated loading.

C. Pretension: install membranes to approximately 5 lb of tension per square foot of membrane ("trampoline tight"), so the membrane moves as a single surface under wind and does not flutter.

D. Geometry: four-or-more-point membranes shall have a height differential of not less than [2 ft] between high and low corners. Three-point membranes shall slope for drainage.

E. Code compliance, according to how the AHJ classifies the work:

1. As a tensile membrane structure (IBC 3102, structures erected 180 days or longer): design and construct to ASCE 55 (3102.2); membrane noncombustible or meeting NFPA 701 flame propagation (3102.3.1); design for dead, tension, wind and other loads per Chapter 16 (3102.7); do not rely on the membrane for lateral restraint of frame members (3102.7.1).
2. As an awning or canopy (IBC 3105): design for wind and live loads per Chapter 16, with allowance for open construction (3105.2); covering meeting NFPA 701 flame propagation, or a flame spread index not greater than 25 per ASTM E84 (3105.3).
3. Wind: ASCE 7 as referenced by IBC Chapter 16, using the site's basic wind speed, exposure and risk category.

1.6 SUBMITTALS

A. Product data: membrane fabric manufacturer's current product profile, including mass, grab tensile, tongue tear, ball burst, ASTM E84 rating, and AS 4174 UV block and shade factor for the selected color; biaxial elastic properties when requested by the delegated-design engineer.

B. Field dimension report: each membrane's sides, diagonals and connection heights as measured by the fabricator's personnel, with the fabricator's closure check showing the measurements are mutually consistent, before fabrication.

C. Shop drawings: plan and 3D geometry of each membrane, flattened (patterned) dimensions, edge curve, corner and hardware details, hardware schedule, and pretension target.

D. Delegated-design submittal: sealed drawings and calculations per 1.5.A.

E. Samples: [color card] [12 in. square fabric sample] for color selection; one full-size corner assembly of the type specified for the largest membrane.

F. Qualification data: documentation demonstrating compliance with each requirement of 1.7, including a list of completed projects with owner contacts.

G. Closeout: operation and maintenance instructions per 3.5, and warranty documents.

1.7 QUALITY ASSURANCE

A. Fabricator qualifications:

1. A firm in continuous operation for not less than [15] years whose business includes custom fabrication of sewn commercial textile products and tensioned fabric membranes.
2. Membranes patterned, cut and sewn in the fabricator's own facility in the United States [within [50] miles of the project site]. Outsourcing of membrane fabrication is not permitted.
3. Fabricator's personnel, not a third party, take field dimensions and perform a three-dimensional closure check of sides, diagonals and connection heights before cutting.
4. Fabricator's principal or designated design lead has not less than [10] years of experience designing and fabricating tensioned fabric shade structures.
5. Fabricator holds, or is under common ownership with a firm that holds, a current Arizona Registrar of Contractors license covering this work.

B. Installer qualifications: a licensed Arizona contractor in continuous operation for not less than [25] years, under common ownership with the fabricator or the fabricator itself, using its own employees for membrane installation and tensioning.

C. Pre-installation meeting: conduct at the site with the Contractor, delegated-design engineer and fabricator before setting posts or anchors.

1.8 SUBSTITUTIONS

A. Basis of design is stated in 2.1. Proposed equivalents will be considered only when submitted not less than [10] days before bids are due and accompanied by:

1. Documentation of compliance with every requirement of 1.7, item by item.
2. Not fewer than [10] completed tensioned fabric projects of comparable size and complexity within the past [5] years, with owner references.
3. Product data and test reports demonstrating fabric, thread, cable and hardware equal to Part 2.
4. A full-size corner assembly sample and a sample of seam and edge-pocket construction.
5. Access for the Architect to inspect the proposed fabricator's facility, at the requester's expense.
6. A written statement accepting single-source responsibility under 1.1.B.

B. The Architect's decision is final. Requests after bid will not be considered, and incomplete requests will be returned without review.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver membranes rolled or folded on padded cores, labeled by membrane and corner. Store dry, off the ground and protected from cutting edges and heat.

1.10 FIELD CONDITIONS

A. Do not fabricate until field dimensions are verified and the field dimension report is approved. Connection points shall be installed and accessible for measurement.

1.11 WARRANTY

A. Fabric: membrane fabric manufacturer's 10-year limited warranty against UV degradation.

B. Fabricator's workmanship (seams and stitching): 90 days from delivery or completion of installation, including 100 percent of labor.

C. Installation: the installer's Arizona statutory 2-year limited labor warranty.

D. Exclusions: hardware and powder coating except as covered by their manufacturers; damage from wind or storm events, from membranes not taken down as instructed, from improper tensioning or modification by others, and from fire or heat sources.

PART 2 – PRODUCTS

2.1 FABRICATOR

A. Basis of design: American Upholstery (Custom Upholstery, LLC), 4970 N 7th Ave, Phoenix, AZ 85013; (480) 399-7516; americanupholstery.com.

B. Equivalent fabricators: only as approved under 1.8.

2.2 MEMBRANE FABRIC

A. Basis of design: GALE Pacific Commercial 95, knitted HDPE monofilament and tape shade fabric, virgin-grade polymers, heat-set. Color: [as selected by Architect].

B. Minimum properties (manufacturer's published typical values):

PROPERTY	VALUE	TEST
Mass	340 g/m ² (10 oz/yd ²)	AS 2001.2.13
Grab tensile, warp / weft	189 / 462 lbf	ASTM D5034
Tongue tear, warp / weft	52 / 52 lbf	ASTM D2261
Ball burst	422 lbf	ASTM D6797
UV block, selected color	not less than 91%	AS 4174:2018
Surface burning	Class A	ASTM E84

C. The basis-of-design fabric is ASTM E84 Class A (flame spread index 0 to 25), meeting IBC 3105.3 for canopies. Where the AHJ classifies the work under IBC 3102, provide the manufacturer's fire-retardant version with test data demonstrating NFPA 701 compliance.

2.3 THREAD

A. UV-stable thread rated by its manufacturer for continuous outdoor exposure: [PTFE] [solution-dyed UV-stabilized polyester].

2.4 EDGES AND PERIMETER CABLE

- A. Edges cut to a catenary (inward) curve and finished with a sewn perimeter pocket of not less than 2-1/2 in., with [1/4 in.] Type 316 stainless steel 7x19 wire rope running continuously through the pocket. [Alternate: 1 in. polyester webbing binding where approved for small membranes.]
- B. Perimeter cable length: perimeter plus 15 percent take-up, with four stainless wire rope clamps per continuous cable.

2.5 CORNER HARDWARE

- A. Corner hardware shall increase with membrane area, measured from field dimensions:

MEMBRANE AREA	CORNER TYPE
Up to 200 sq ft	Welded Type 316 stainless D-ring, sewn into multi-layer reinforced corner
Over 200 to 400 sq ft	Pro-Rig style corner (any brand): a heavier stainless D-shaped ring with a groove the perimeter cable slips through
Over 400 sq ft	Sandwich (commercial) bracket: corner clamped between two stainless plates

- B. Sandwich brackets may be used at any membrane size where selected for appearance.

2.6 TENSIONING AND CONNECTION HARDWARE

- A. Type 316 stainless steel throughout: jaw-jaw turnbuckles; [4:1 block-and-tackle tensioners with UV-resistant braided line and cleats]; shackles; pad eyes and eye bolts sized by the delegated-design engineer.
- B. Lead lines, where a corner falls short of its connection point: Type 316 wire rope, length equal to the remaining distance plus 15 percent, with two wire rope clamps at each end.

2.7 STEEL [IF INCLUDED]

- A. Posts and extensions: ASTM A500 Grade C hollow structural sections with base plates, sized by the delegated-design engineer; welding to AWS D1.1; [hot-dip galvanized] [powder coated, color to match] [primed for field painting].

2.8 FABRICATION

- A. Pattern each membrane from the approved field dimensions. Flatten twisted membranes by distributing the height differential evenly about a middle plane, and reduce the membrane from field dimensions to allow for hardware and pretension.
- B. Arch-supported (barrel vault) membranes: pattern curved edges to the arc length computed from the measured chord and rise.
- C. Reinforce each corner with multiple layers of membrane fabric [and webbing]. Sew seams and pockets with the specified thread; no adhesive-only seams.
- D. Label each membrane and corner to match the shop drawings.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that footings have cured, posts and embeds are set to the delegated design, and connection points are installed, accessible and free of obstructions. Report deficiencies in writing before measuring.

3.2 FIELD DIMENSION VERIFICATION

- A. Fabricator's personnel measure each membrane point to point at the actual connection points: every side, all diagonals (for five- and six-point membranes, each diagonal from one corner), and the height of each connection point.
- B. Perform a three-dimensional closure check. Where sides, diagonals and heights cannot all be true together, or the twist implied by the diagonals differs from the measured height differential, re-measure before fabrication. Tolerance: [3 in.] per dimension.
- C. Submit the field dimension report under 1.6.B. Do not fabricate until approved.

3.3 INSTALLATION

- A. Install membranes, cables and hardware per approved shop drawings, with each corner at its labeled connection point.
- B. Pretension each membrane evenly, working around the corners in turn, to approximately 5 lb per square foot of membrane, using a come-along of adequate capacity (typically 1 or 2 ton) and then transferring load to the permanent tensioning hardware. The finished membrane shall be taut, free of wrinkles and flutter, and shall move as one surface.
- C. Do not over-tension: posts, anchors and supporting structure shall not visibly deflect under pretension.
- D. Maintain clearances from heat sources, light fixtures and roof drainage as shown, and the minimum clear height of [8 ft] above walking surfaces.

3.4 FIELD QUALITY CONTROL

- A. Fabricator shall inspect each completed membrane for tension, alignment, corner seating and hardware locking, and submit a written record.
- B. [Re-check and re-tension membranes [30] days after installation.]

3.5 OWNER INSTRUCTION

- A. Provide written operation and maintenance instructions and demonstrate:
 - 1. Re-tensioning, in spring and fall and after strong winds.
 - 2. Take-down: release the low-corner tensioners and remove membranes before forecast severe storms, as a rule of thumb winds over about 50 mph, unless the delegated design states otherwise.
 - 3. Cleaning: hose, mild soap and soft brush; no bleach or pressure washer.

3.6 CLEANING AND PROTECTION

- A. Remove debris and packaging, clean soiled fabric as above, and protect installed membranes from construction activity until Substantial Completion.

END OF SECTION 13 31 23

Sources: GALE Pacific Commercial 95 product profile, Rev. 18 (08/2023); 2021 IBC Chapter 31 model text; City of Phoenix 2024 code adoption (effective August 1, 2025).