

# SPECIFICATIONS FOR ALUMINUM GEODESIC LAPPED DOMES

## I. GENERAL

### A. Purpose

This specification establishes minimum criteria for the design, fabrication and erection of aluminum dome roofs and is applicable except as otherwise noted.

### B. Definition

An aluminum dome roof is a fully triangulated aluminum space frame with the struts joined at points arrayed upon the surface of a sphere with aluminum closure panels firmly attached to the frame members. The roof shall be attached to and supported by the tank at a number of mounting points equally spaced around the perimeter of the tank. The number of mounting points shall be determined by the roof manufacturer.

### C. References

The latest editions of the following codes and standards form a part of this specification to the extent specified herein:

1. ASCE 7 Minimum Design loads for Buildings and other Structures.
2. ASTM C509 Standard Specifications for Cellular Elastomeric Preformed Gasket Sealing Material.
3. Aluminum Association Aluminum Design Manual.
4. AISI Stainless Steel Cold – Formed Structural Design Manual.
5. AWWA D-100 or D-103.
6. ASTM F 593 Standard Specification for Stainless Steel Bolts.

## II. DESIGN REQUIREMENTS

### A. Description

1. The dome roof shall be a spherical structure conforming to the specified dimensions. The dome shall be a fully triangulated space frame complete with non-corrugated closure panels. The dome shall be clear – span and designed to be self – supporting from the periphery structure with primary horizontal thrust contained by an integral tension ring to avoid imposing radial loads on the tank rim. **On new tankage the top of the tank may be alternatively designed to sustain the horizontal thrust transferred by the dome through fixed supports.**
2. Skin panels shall overlap by a minimum of 4” in a down-hill overlapping fashion to preclude water entry at the joints or seams. Skin panel fasteners shall be stainless steel with a separate elastomeric gasket and stainless steel domed washer.

3. The entire structure shall be designed as a watertight system under all design load conditions. Hub covers at panel intersections shall be flanged and provide a minimum of 3 ½" overlap, and shall not form water dams or puddles.
4. Primary triangular closure panel fasteners must engage an extruded groove in the supporting beam which is sized in width and depth to develop the full breaking strength of the fastener (when over tightened, the fastener will break before the formed threads will strip out). In no case will the groove be less than ¾" deep. The fastener's thread form will be specifically designed to "Roll Form" threads into the sides of the groove (rather than "cut" threads).
5. Dome slide/support leg shall be a rigid, shop welded assembly sliding on a Stainless Steel – on – Teflon slide bearing mounted on a baseplate. Design of the aluminum welds shall account for the adjacent heat affected zone in accordance with Aluminum Association Specifications. Adjustable type support legs which rely upon a single pivot pin are expressly prohibited.

## **B. Submittals**

Before executing any of the work in this section, an approval package shall be submitted to the purchaser showing dimensions, sizes, thicknesses, gauges, materials, finishes, joint attachment and erection procedure. A complete stress analysis summary showing load criteria and maximum stresses, including a comparison to the allowable stresses for the dome (s) specified shall also be submitted. This package shall be signed by a registered professional engineer.

## **C. Materials**

### **1. General**

All materials furnished to meet the provisions of the specification shall be new, previously unused, in first class condition, and shall comply with all the requirements of this specification. A complete material specification shall be submitted by the roof manufacturer for approval by the purchaser. The choice of materials should be governed by compatibility with the product specified to be stored in the tank and the surrounding environment. All aluminum alloys, properties and tolerances shall be defined by the Aluminum Association's Aluminum Standards and data, latest edition.

### **2. Structural Frame**

All structural frame members shall be suitable aluminum shapes from 6061 – T6 or a recognized alloy with established properties.

### **3. Closure Panels**

Closure panels shall be fabricated from 3000 series aluminum with a minimum nominal thickness of 0.050".

#### 4. Bolts

All bolts shall be 7075 – T73 aluminum, 2024 – T4 aluminum, or series 300 stainless steel. Only stainless steel fasteners shall be used to attach aluminum to carbon steel. All primary structural fasteners shall be 1/2" minimum nominal diameter. All fasteners exposed to the elements will be stainless steel or aluminum. All bolts shall be removable and replaceable with common hand tools.

#### 5. Closure Panel Screws

Closure panel screws shall be 300 series stainless steel type AB self – tapping screws with a separate elastomeric gasket under a 300 series stainless steel domed washer. Minimum fastener shall be #14 (1/4" nominal) with a 5/8" minimum diameter domed washer.

#### 6. Anchor Bolts: 300 Series Stainless Steel

#### 7. Sealants

All sealants shall be silicone compounds conforming to Federal Specification TT-S-00230C unless another material is required for compatibility with stored materials. Sealants shall remain flexible over a temperature range of -80 to +300 degrees F without tearing, cracking or becoming brittle. Elongation, tensile strength, hardness and adhesion shall not change significantly with aging or exposure to ozone or ultraviolet light. Sealants shall be held in place by the sealed components; sealant shall not rely upon adhesion to aluminum to be held in place or to seal. Sealant shall form a molded – in – place gasket rather than a "filleted" bead of caulk.

#### 8. Gaskets

All preformed gasket material shall be silicone elastomer GE No. SE – 44/88 or equal meeting ASTM C 509 or Federal Specification ZZ-R-175, Class 2 Grade 50 unless another material is required for compatibility with stored materials.

#### 9. Slide Bearing Pads: Stainless Steel on Teflon.

#### 10. Dormers, doors, vents, and hatches shall be 6061 – T6 or 5052 H32 aluminum.

#### 11. Skylight panels, if required, shall be clear acrylic with a minimum nominal thickness of 0.25".

### D. Allowable Stresses

#### 1. Aluminum Structural Members and Panels

Aluminum structural members and connections shall be designed in accordance with the Aluminum Association's Specifications for Aluminum Structures.

## 2. Bolts

Bolts shall be selected according to the following table:

<u>Material</u>	<u>Allowable Tensile Stress (KSI)</u>	<u>Allowable Shear Stress (KSI)</u>
2024 – T4 Aluminum	26.0	16.0
7075 – T73 Aluminum	28.0	17.0
300 Series Stainless Steel ( $F_{tu}=90$ ksi)	25.0	18.0
300 Series Stainless Steel ( $F_{tu}=125$ ksi)	34.0	25.0
300 Series Stainless Steel ( $F_{tu}=\text{other}^*$ )	28% of $F_{tu}$	20% of $F_{tu}$
Grade 5 Steel	27.0	22.0
Grade 8 Steel	54.0	32.0

Note: Tensile Stress applied to root of thread area. Shear Stress applied to area in plane of shear.

\*Minimum Ultimate Tensile Strength

## 3. Closure Panel Screws

Closure panel screws shall meet the following minimum requirements:

<u>Material</u>	<u>Allowable Tensile Stress (KSI)</u>	<u>Allowable Shear Stress (KSI)</u>
300 Series Stainless Steel ( $F_{tu}=129$ )	35.0	25.8

## E. Design Loads

1. The dome shall be designed in accordance with the “Specifications for Aluminum Structures” as published by the “Aluminum Association” and designed for dead load plus live load conditions as required by U.S. standard building codes.
2. The magnitude of the loads applied to the structure shall be determined in accordance with **ASCE 7 or other specified code.**
3. The load cases to be considered shall be those described below:
  - a. Dead Load – The dead load shall be defined as the weight of the structure and all material permanently attached to and supported by the structure.
  - b. Snow Load – The ground snow load as defined in Section 7 of ASCE 7 shall be \_\_\_\_\_ (unheated structure).
  - c. Wind Load – The wind load shall be applied in accordance with ASCE 7, Sections 6.5 thru 6.7 for a \_\_\_\_\_ mph wind speed, exposure \_\_\_\_\_

- d. Seismic Zone – The seismic loading as defined in ASCE 7 section 9 with an occupancy importance factor of 1.0 for seismic zone 0 1 2 3 4 (circle one).
- e. Panel Design Load – In addition to the above mentioned loads, the panels shall be designed for a 250 pound load distributed over one square foot at any location or a 60 psf load distributed over the entire area of any given panel without sustaining permanent distortion. These loads are to be taken separately and not simultaneously with other design loads.

### **III. DOME ACCESSORIES**

- A. One (1) personnel entryway – dormer and door. The entryway shall have vertical access with a \_\_\_\_\_ head clearance throughout the dormer. The access door shall be an aluminum flush panel door with .125" thick panels with Stainless Steel hardware and hinges. The aluminum door frame shall be 1 – ¾" x 4" with .125" thick material. The door shall be \_\_\_\_\_' - \_\_\_\_\_" wide x \_\_\_\_\_' - \_\_\_\_\_" high.
- B. One (1) vent mounted on top center, with bird screen. Vent shall also be suitable for use as a scaffold support.
- C. ¼" Acrylic skylight panels shall be provided to cover 1% of dome area. They shall be designed to sustain the panel loads as defined in E.3.e.
- D. Dome Walls – The dome may be supported on peripheral walls which raise the dome above the tank rim. The dome walls shall be designed to support the dome under all loading conditions as defined in section E. of this specification. The wall shall be fully triangulated and complete with non-corrugated closure panels stamped and patterned to match the dome panels. Wall panels shall be designed to overlap by a minimum of 4" in a down hill overlapping fashion to preclude water entry at the joints and seams. The wall may be fixed to the dome and equipped with Stainless Steel on Teflon slide bearings at the base, or fixed to the wall and connected to the dome with slide bearings.

### **IV. INSTALLATION**

All work shall be executed by skilled mechanics experienced in the fabrication and erection of aluminum domes. The dome shall be erected plumb and level and in proper alignment.

### **V. MANUFACTURER**

The Aluminum Geodesic Dome shall be the acceptable Lapped Design Ultradome as manufactured by Ultraflote Corporation; Houston, TX (713) 461-2100.

### **VI. WARRANTY**

The dome manufacturer shall warrant that the work described herein shall be free from defects in workmanship and material. The dome manufacturer shall replace or repair any faulty workmanship or defective material furnished by it that is reported to it within one (1) year from date of acceptance for this work.