

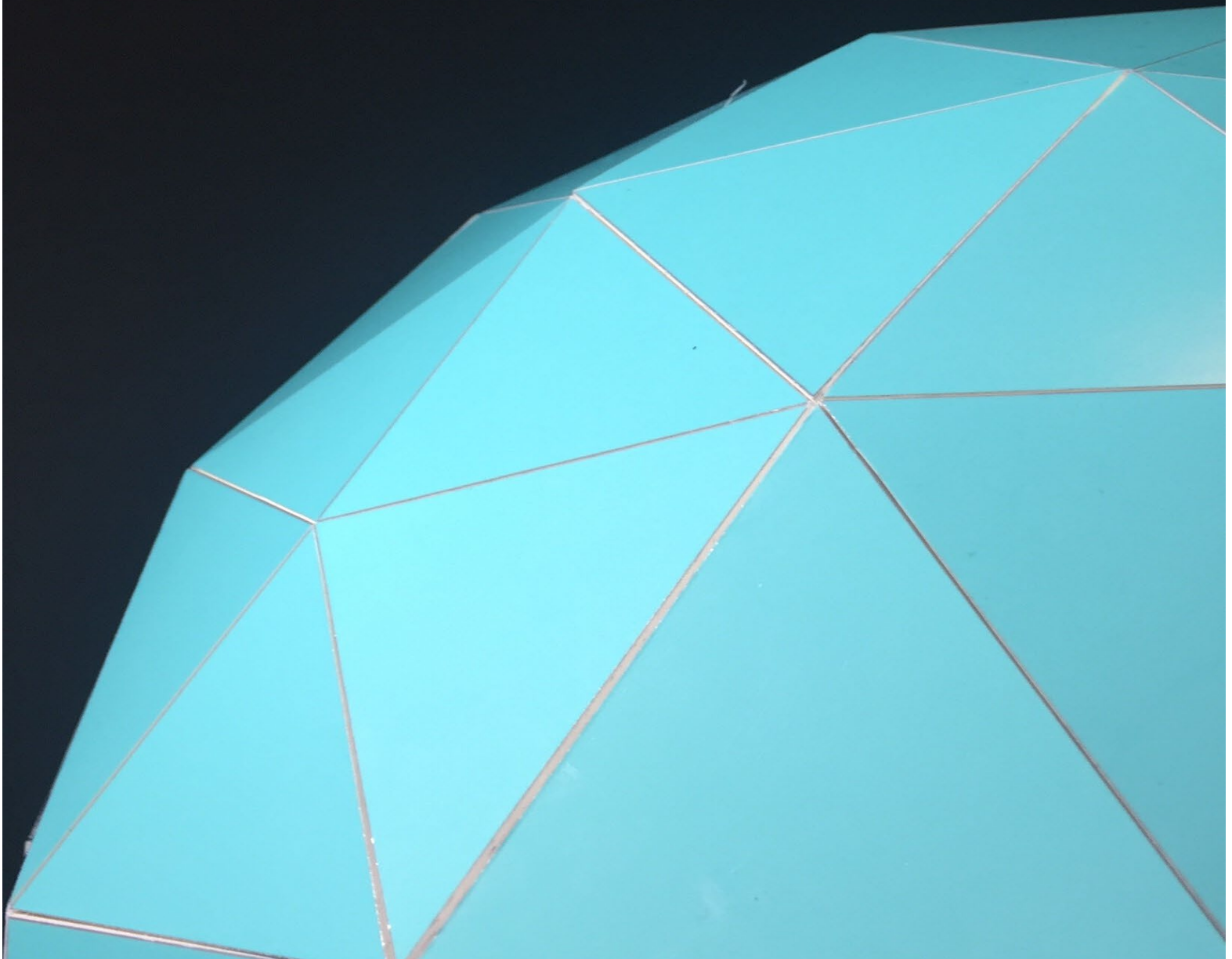
# Foldable Dome Home

Solving Homelessness Without Environmental Harm

HGU Build A Better Future Scholarship

Christian Duckworth

2022



## Design Goals

I approached the Foldable Dome Home with three design goals in mind: (1) make it highly enjoyable and easy to live in, (2) make it highly space and energy efficient, and (3) make it highly efficient to assemble, disassemble, and transport. According to the American Institute of Architects, the geodesic dome is "the strongest, lightest and most efficient means of enclosing space yet known to man." As such, I used a geodesic dome as the basis for my design solution.

### **1. Make it highly enjoyable and easy to live in**

Maximizing the efficiency of a house is meaningless if the space is not nice to live in. Geodesic domes are fun and inspirational, which is why Disney World built one as its centerpiece attraction at Epcot. My Foldable Dome Home is equally fun and inspirational due to its many unique design features, including: the round shape of its plan, the interesting spherical shape and triangular pattern of its roof, the sleeping loft that allows the space to be experienced at different levels, the functionality of its service core, and the ample natural light from its windows.

### **2. Make it highly space and energy efficient**

With a footprint of just 254 square feet, and a total livable area of just 310 square feet, the Foldable Dome Home is highly space efficient, yet it does not feel confined because of the dome's ample interior volume. Its service core provides over 10 convenient fixtures and functions in a footprint of just 56 square feet, including: full bathroom with sink/toilet/shower, sleeping loft for two people, stove, microwave, kitchen sink, refrigerator, washer, dryer, HVAC unit, flat-screen TV, eight linear feet of kitchen cabinets, and 24 cubic feet of general storage. It is also highly energy efficient with 23 square feet of solar panels, highly insulated building shell, operable windows for natural ventilation, and LEED certification.

### **3. Make it highly efficient to assemble, disassemble, and transport**

When disassembled, one entire Foldable Dome Home fits inside an 8'6" cube, which allows six Homes to be transported together on a single 51-foot-long flatbed trailer. This is achieved by integrating the structure and skin of the Home's building shell into thin, highly insulated, structural panels, which can be folded at the seams and stacked. The 75 triangular panels from the dome's top are stored inside the bathroom, and the 15 rectangular panels from the dome's skirt are stored in the sleeping loft, all within the 8'6" cube. Neither the service core nor any of its fixtures require assembly, but act as one portable component. The service core also serves as the shipping container for the whole building shell.

## Description of Construction Systems

### Building Shell

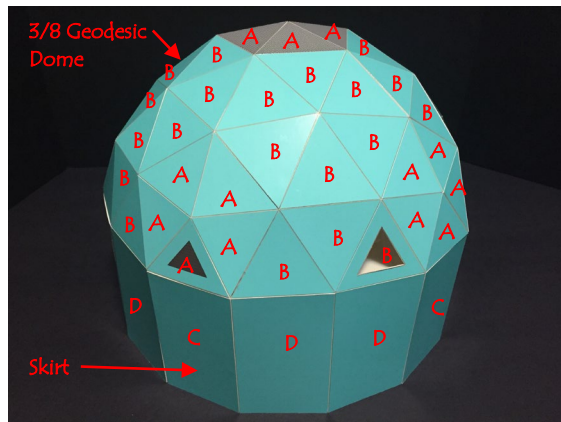


Figure 1

The building shell is an 18-foot diameter, 3v 3/8 geodesic dome that sits on top of a vertical skirt to maximize the usable space near the interior edge of the dome (see Figure 1). The dome's top is comprised of 75 isosceles triangles of two different sizes. While both triangles have the same size base, which is 3'7-5/8" long, 30 of them have sides that are 3'1-5/8" long (see "A"), and 45 of the them have sides that are 3'8-1/2" long (see "B"). The dome's skirt is comprised of 15 rectangles of two different sizes. While both rectangles have the same length, which is 7'0", five of them are 3'1-5/8" wide to match the sides of the smaller triangles (see "C"), and 10 of them are 3'8-1/2" wide to match the sides of the larger triangles (see "D"). The edges of every panel are color coded for easy assembly on site.

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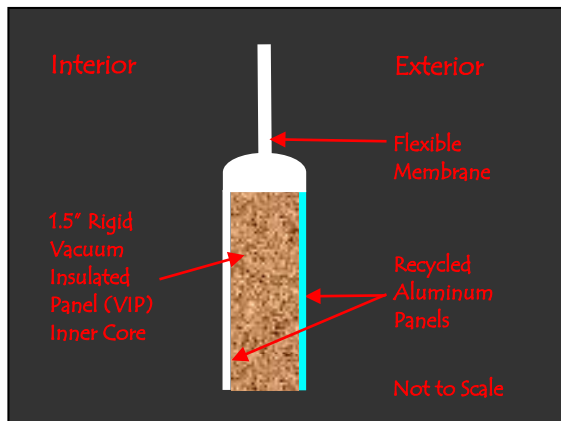


Figure 2

All of the panels, regardless of whether they are triangular or rectangular, are constructed with a recycled aluminum outer shell, and a rigid vacuum insulated panel (VIP) inner core (see Figure 2). Together these materials make a building shell that not only performs well thermally but is also thin, lightweight, and highly weather resistant. The panel seams are made of a flexible membrane that is attached to the VIP inner core, resulting in a highly durable, waterproof hinge. The building shell can be freestanding or anchored to any level surface. It incorporates one entry door and two windows on the ground floor, and one window in the sleeping loft, which also functions as an emergency exit in accordance with 2018 ICC Section AQ105 (see Figure 3; please note that two-fifths of the dome's top is not shown for display purposes only). It also incorporates one vent for the HVAC system, and 23 square feet of solar panels, which provide clean energy that can be used in real time and/or stored in batteries for future use (see Figure 4).

All of the panels, regardless of whether they are triangular or rectangular, are constructed with a recycled aluminum outer shell, and a rigid vacuum insulated panel (VIP) inner core (see Figure 2). Together these materials make a building shell that not only performs well thermally but is also thin, lightweight, and highly weather resistant. The panel seams are made of a flexible membrane that is attached to the VIP inner core, resulting in a highly durable, waterproof hinge. The building shell can be

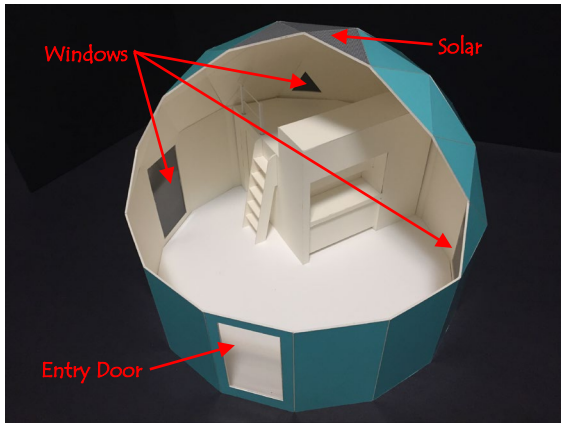


Figure 3

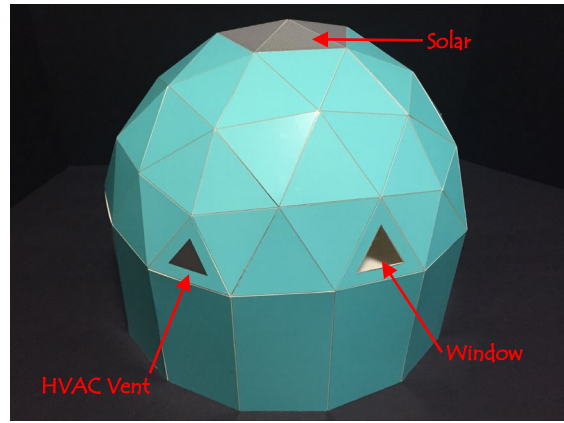


Figure 4

### Service Core

The service core fits inside an 8'6" cube (see Figure 5) and provides over 10 convenient fixtures and functions in a footprint of just 56 square feet, including: full bathroom with sink/toilet/shower, sleeping loft for two people, stove, microwave, kitchen sink, refrigerator, washer, dryer, HVAC unit, flat-screen TV, eight linear feet of kitchen cabinets, and 24 cubic feet of general storage (see Figure 6). It enhances the home's design by naturally separating the living, kitchen, and sleeping areas without the use of walls in order to keep the space open and help the 310 square feet seem as large as possible.

Another important aspect of the service core is that neither it nor any of its fixtures require assembly. I decided to design it this way for three reasons: (1) to reduce the amount of time required for assembly and transportation, (2) to provide a strong structure to support the overhead sleeping loft and storage, and (3) to serve as a readymade shipping container for the building shell. The 75

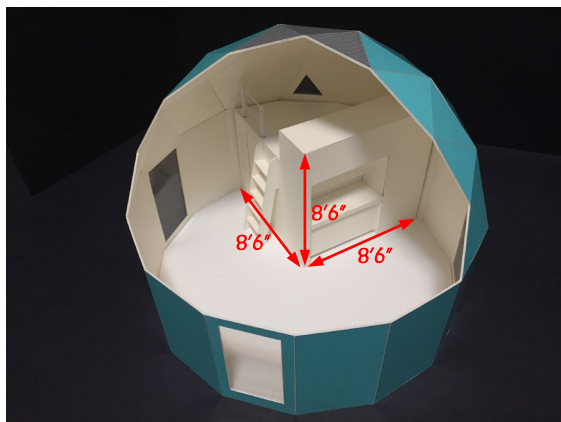


Figure 5

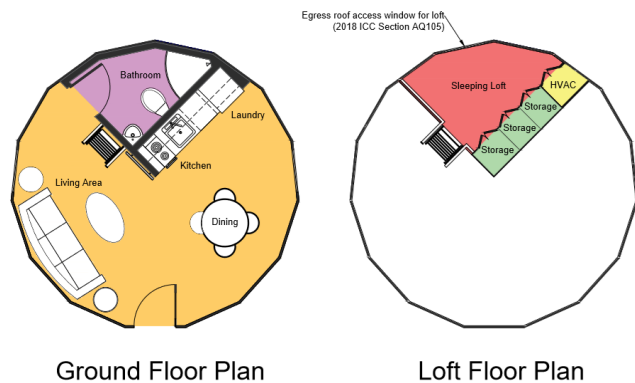


Figure 6

triangular panels from the dome's top are stored inside the bathroom, and the 15 rectangular panels from the dome's skirt are stored in the sleeping loft, all within the 8'6" cube. This allows six Foldable Dome Homes to be transported together on a single 51-foot-long flatbed trailer.

### Plumbing

The Foldable Dome Home's plumbing system is designed to accommodate both "on-the-grid" and "off-the-grid" site applications. As shown in Figure 7, all of the plumbing is contained in one wall of the service core, which saves materials and cost. Three types of pipe are present in the wall: fresh cold water pipe (shown in blue), fresh hot water pipe (shown in red), and grey water pipe (shown in grey). There is no black water pipe because I decided to use a composting toilet to save water. Fresh water can be obtained from the city (see "1") for "on-the-grid" applications, or from the elevated fresh water tank (see "3") for "off-the-grid" applications. The fresh water tank is elevated to provide water pressure in the home if electricity is not available to run the water pump (see "2").

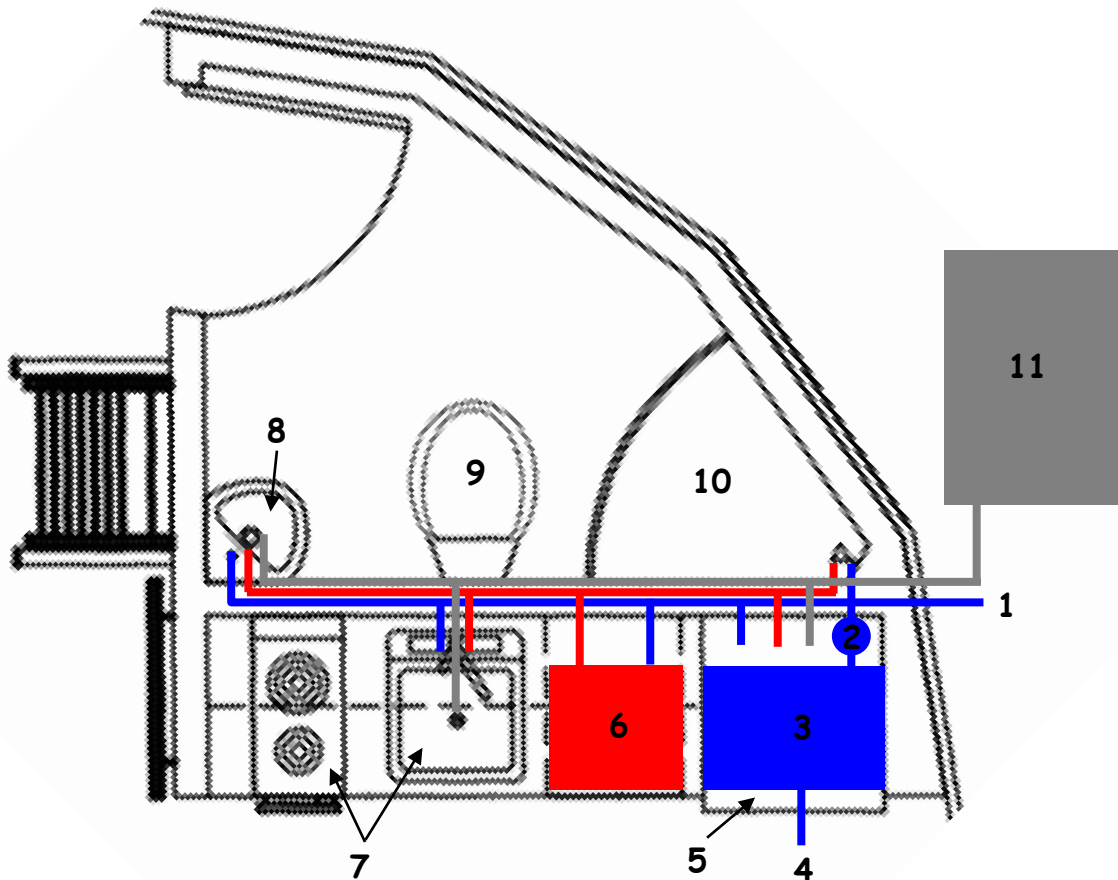


Figure 7

A detailed list of the plumbing fixtures and equipment that are shown in Figure 7 is provided below:



1. City Fresh Water Inlet



2. Ultra Quiet Shurflo Motorhome Water Pump 3 GPM 55 PSI RV Demand Pump (Replaces Shurflo Model 2088-422-444)



3. RV Trailer Camper Fresh Water Polyethylene Fresh Water Tank 40 Gallon 101562000 (Located in cabinet above washer/dryer "5")

4. Fresh Water Fill Spout



5. Westland (Splendide) WD2100XC WhiteVented Washer/Dryer Combo (Located in cabinet under fresh water tank "3")



6. PrecisionTemp RV-550 NSP Instant Water Heater.



7. Delta Collins Single Handle Kitchen Faucet and a Dandby D2000W Compact Kitchen (Stove, Sink, and Refrigerator)



8. Pfizer Selia Single-Hole Faucet and a RV Caravan Camper Corner Round Hand Wash Basin Sink GR-597.



9. Nature's Head Composting Toilet



10. High Sierra 1.5 GPM High Efficiency Low Flow Shower Head and a DreamLine DLT-7038380 SlimLine Rounded Corner Shower Tray



11. Tote-N-Stor 25609 Portable Waste Transport - 32 Gallon Capacity

## Electrical

The Foldable Dome Home's electrical system is designed to accommodate both "on-the-grid" and "off-the-grid" site applications. As shown in Figure 8, all of the electrical is contained in one wall of the service core, which saves materials and cost. For "off-the-grid" applications, DC voltage is generated by 23 square feet of solar panels that are located in five triangles (see "1") at the top of the dome. An inverter (see "3") is used to convert the DC voltage to AC voltage, which then passes through the house breaker panel (see "4") to a series of batteries (see "5") for storage, and/or to power the water pump (see "6"), washer/dryer (see "7"), HVAC system (see "8"), water heater (see "9"), composite toilet fan (see "10"), stove/refrigerator (see "11"), flat-screen TV (see "12"), and lights (see "13"). An exterior connection station (see "1") is provided for the electrical supply to be supplemented by a generator and/or from the power grid when necessary and available.

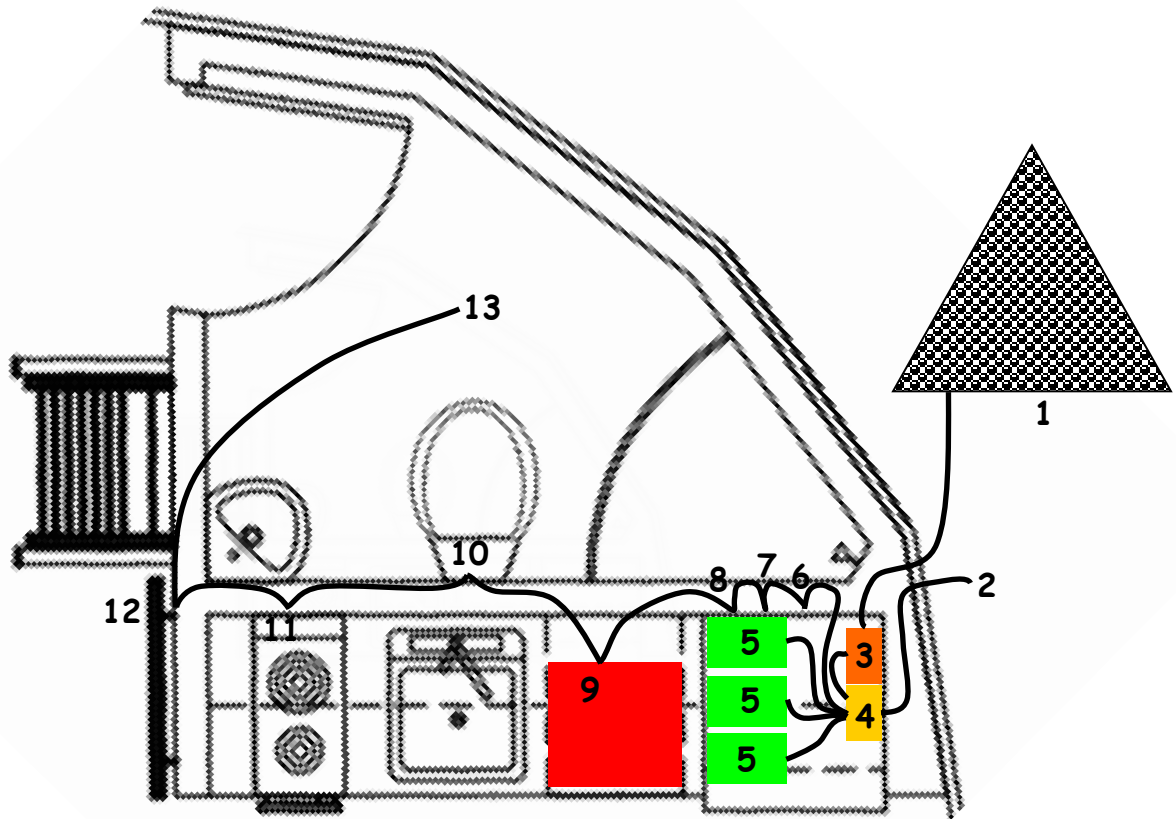


Figure 8

## HVAC System

The Foldable Dome Home is well insulated and has operable windows to facilitate natural ventilation and reduce the need for a centralized HVAC system. However, I decided to include a centralized HVAC system (see Figures 9 and 10) in case the home is located in a climate that has temperature extremes, in which case the electrical supply would need to be supplemented by a generator and/or the grid. The HVAC unit is housed in a sound-proof cabinet (see "1") with direct access to an exterior vent (see "2").

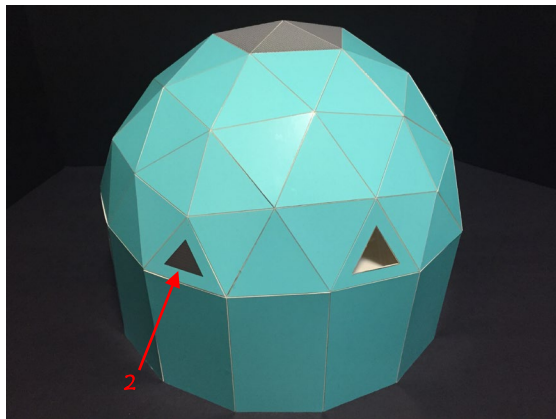


Figure 9

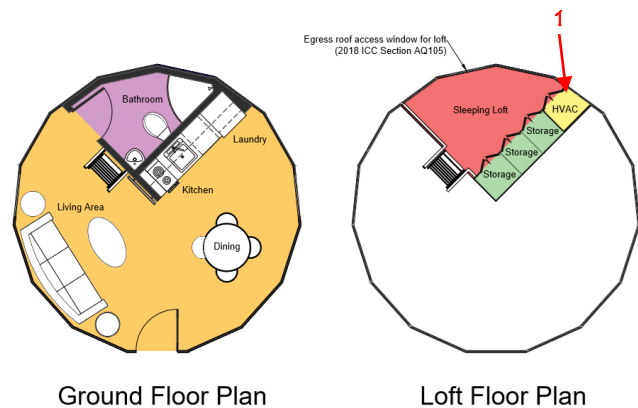


Figure 10

## Building Codes

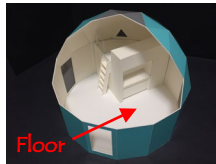
I designed the Foldable Dome Home in accordance with Appendix Q (Tiny Houses) of the 2018 International Residential Code for One- and Two-Family Dwellings, which applies to houses that are 400 square feet in area or less.

- **Ceiling Height:** In accordance with Section AQ103, all ceilings in the Foldable Dome Home's *Habitable Space* are at least 6'8", and the ceiling in its bathroom is at least 6'4".
- **Lofts:** In accordance with Section AQ104, the loft in the Foldable Dome Home is at least 35 square feet. The ladder that accesses the loft has a rung width of at least 12 inches, 10 to 14 inch spacing between rungs, can support at least 200 pounds, and is installed at 70 to 80 degrees from horizontal.
- **Emergency Escape and Rescue Openings:** In accordance with Section AQ105, an egress roof access window is provided in the loft.



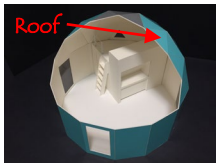
## Schedule of Finish Materials

### Floor



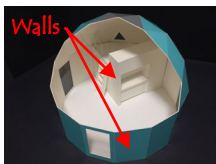
The floor is comprised of interlocking panels that have the same rigid VIP inner core as the roof and walls. The difference is that the seams are interlocking instead of flexible, and the floor surface is polymer instead of aluminum because it is not structural.

### Roof



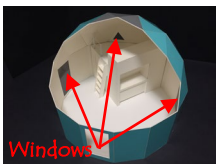
The roof is constructed with a recycled aluminum outer shell, and a VIP inner core (see Figure 2). Together these materials make a building shell that not only performs well thermally but is also thin, lightweight, and highly weather resistant.

### Walls



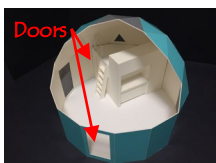
The exterior walls are constructed with a recycled aluminum outer shell, and a VIP inner core (see Figure 2). The interior walls of the service core are made of traditional studs covered with fiberglass reinforced panels (FRP) that contain at least 20% recycled content.

### Windows



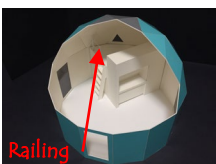
The windows are Alpen Zenith Series ZR10 double-film windows, which have a 0.10 U-Factor. They are operable to allow for cross-ventilation when the weather permits.

### Doors

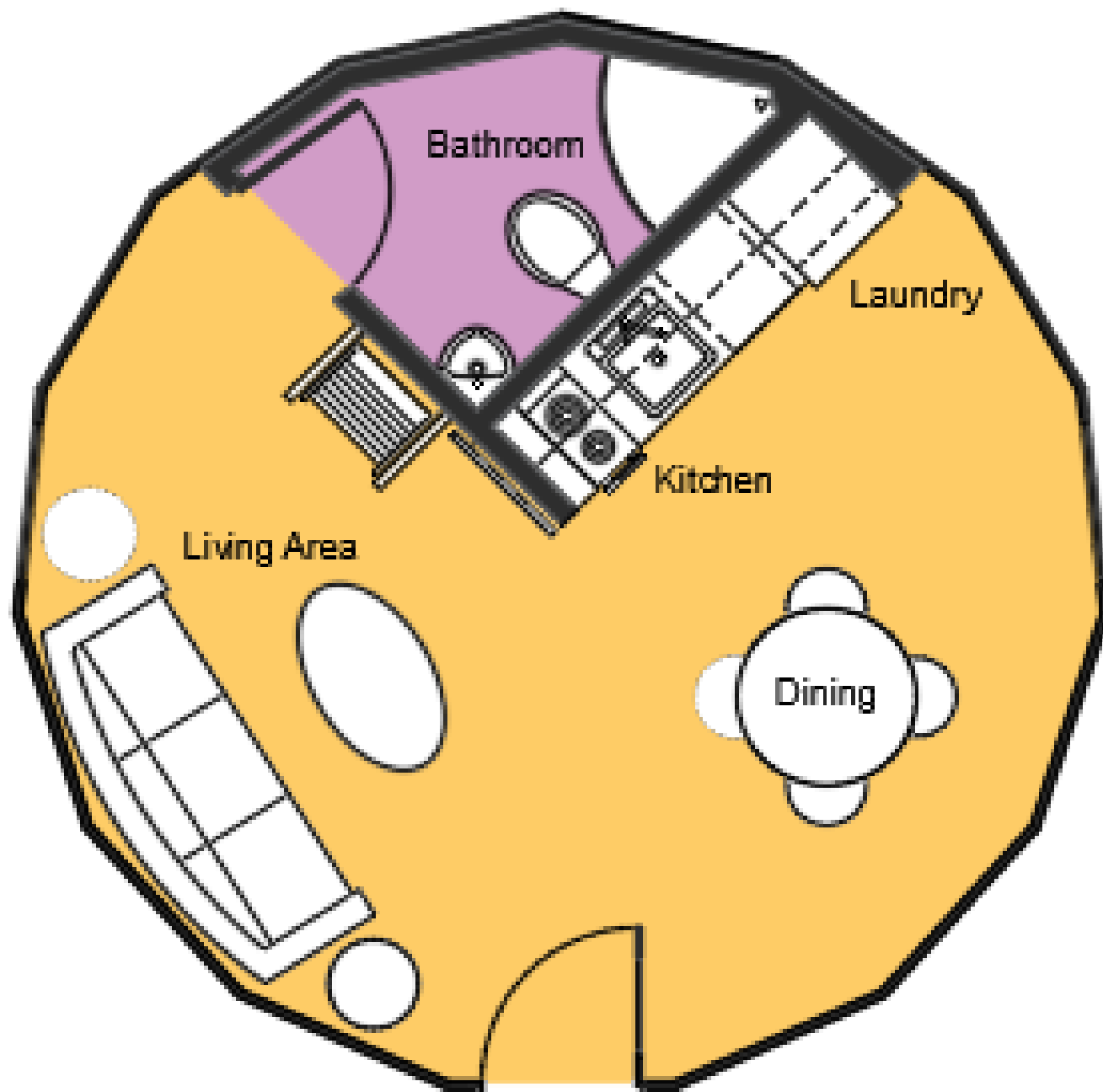


The front door is made of fiberglass and has an Alpen Zenith Series ZR10 double-film window in it. The bathroom door is also constructed of fiberglass.

### Railing



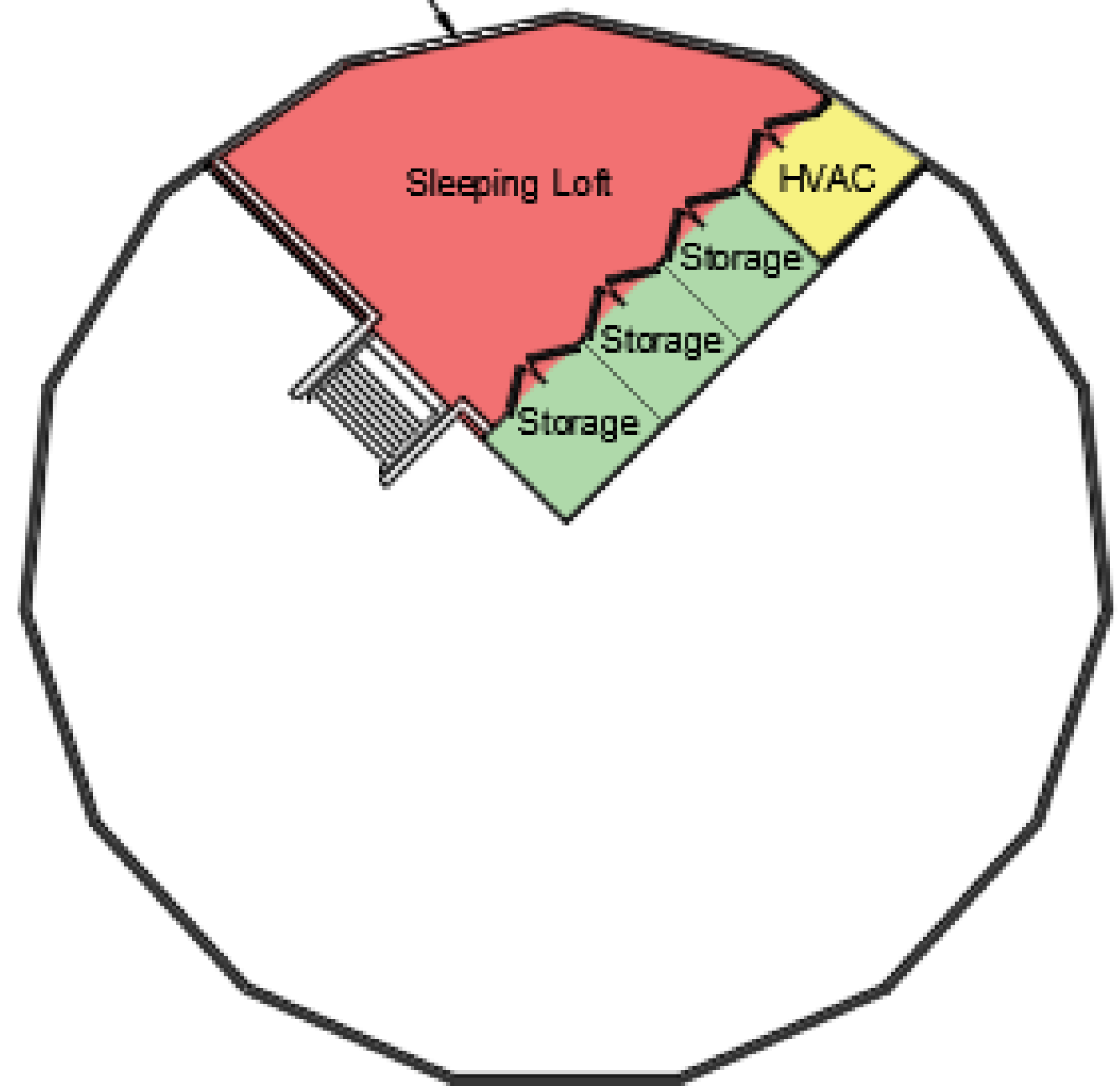
The railings are made from recycled PVC pipe that has been filled and strengthened with recycled plastic. The posts are also made from recycled plastic.



## Ground Floor Plan

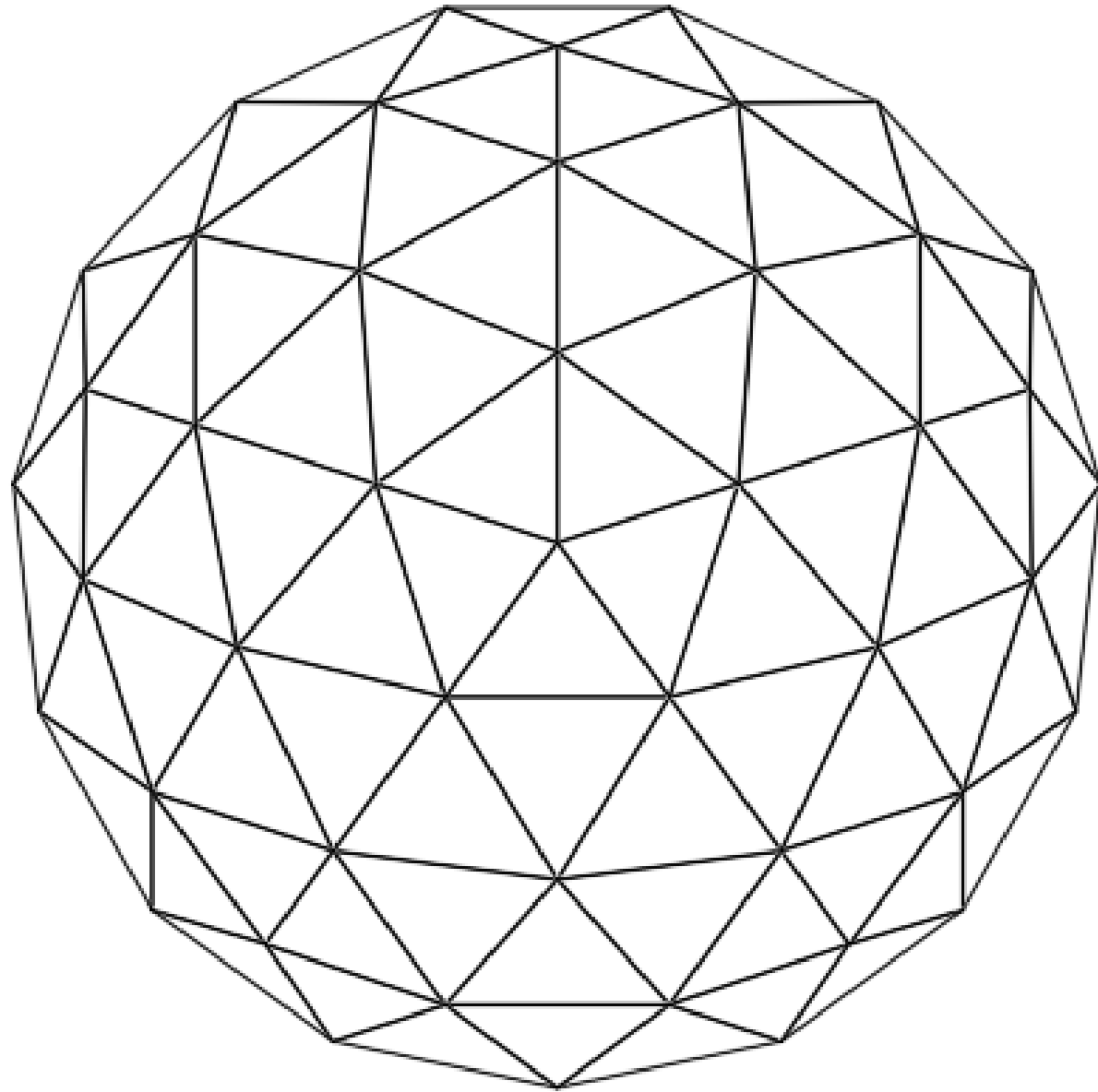
Scale: 3/8" = 1'-0", Area: 254 Sq.Ft., Diameter: 18'-0"

Egress roof access window for loft.  
(2018 ICC Section AQ105)



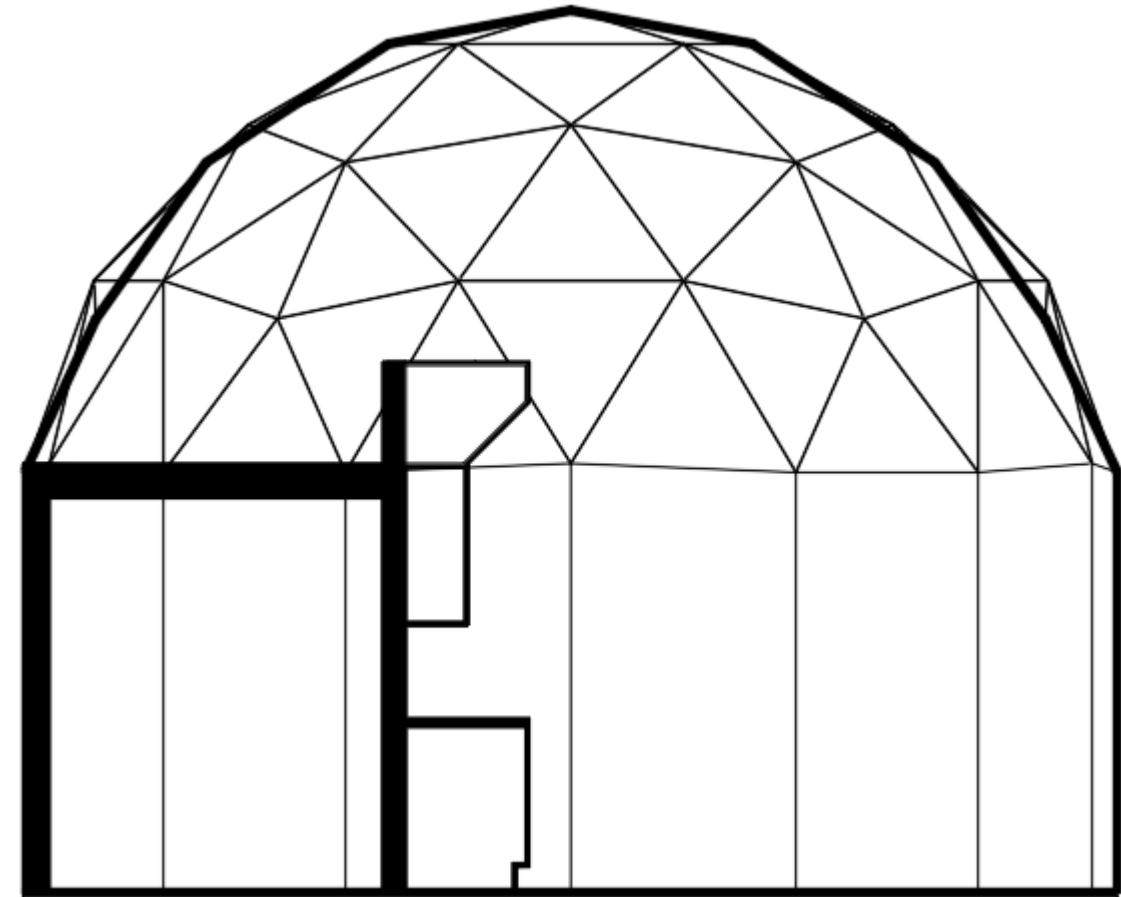
## Loft Floor Plan

Scale: 3/8" = 1'-0", Area: 56 Sq.Ft."



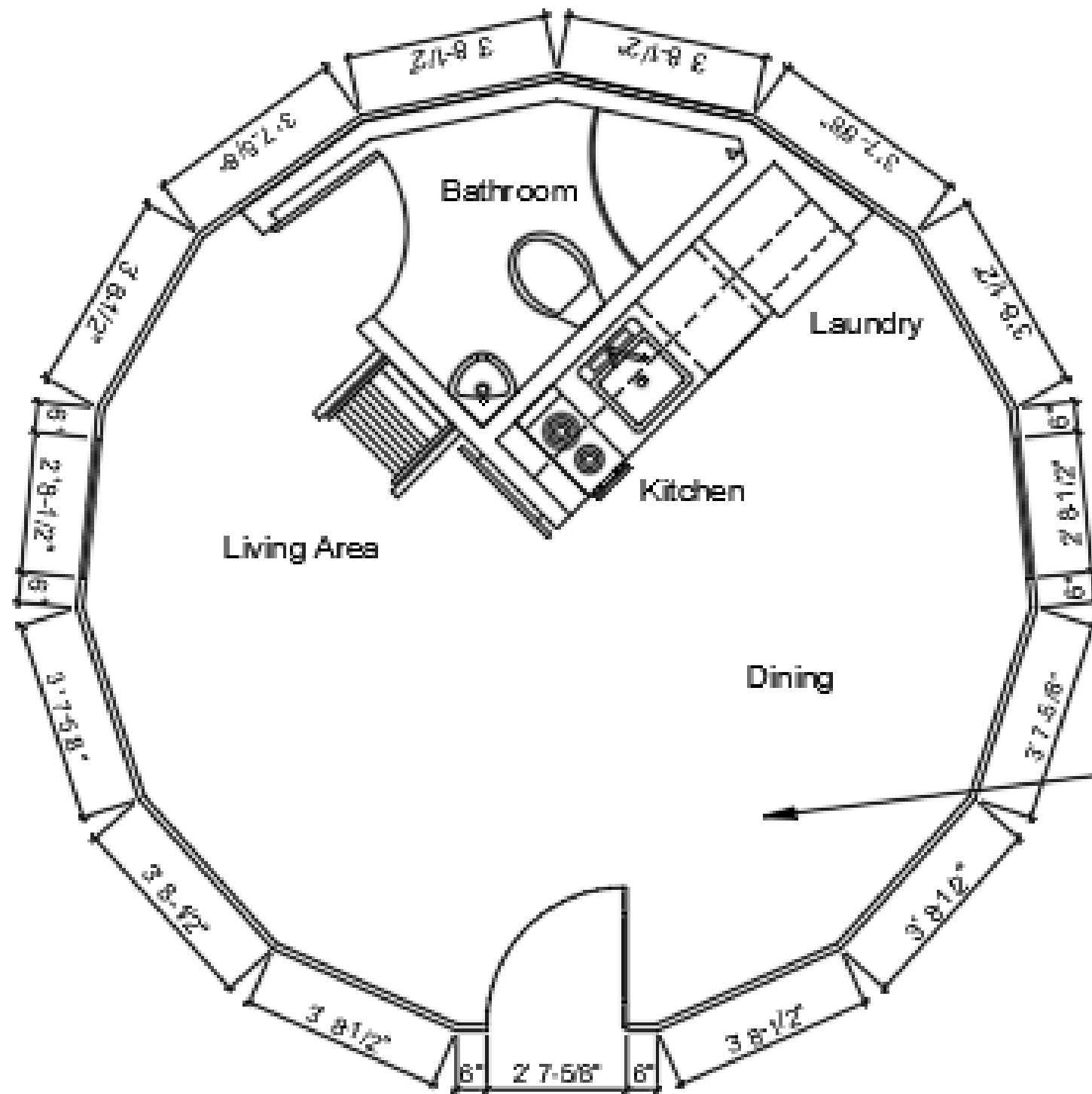
## Roof Plan

Scale:  $\frac{3}{8}'' = 1'-0''$ , Diameter: 18'-0"



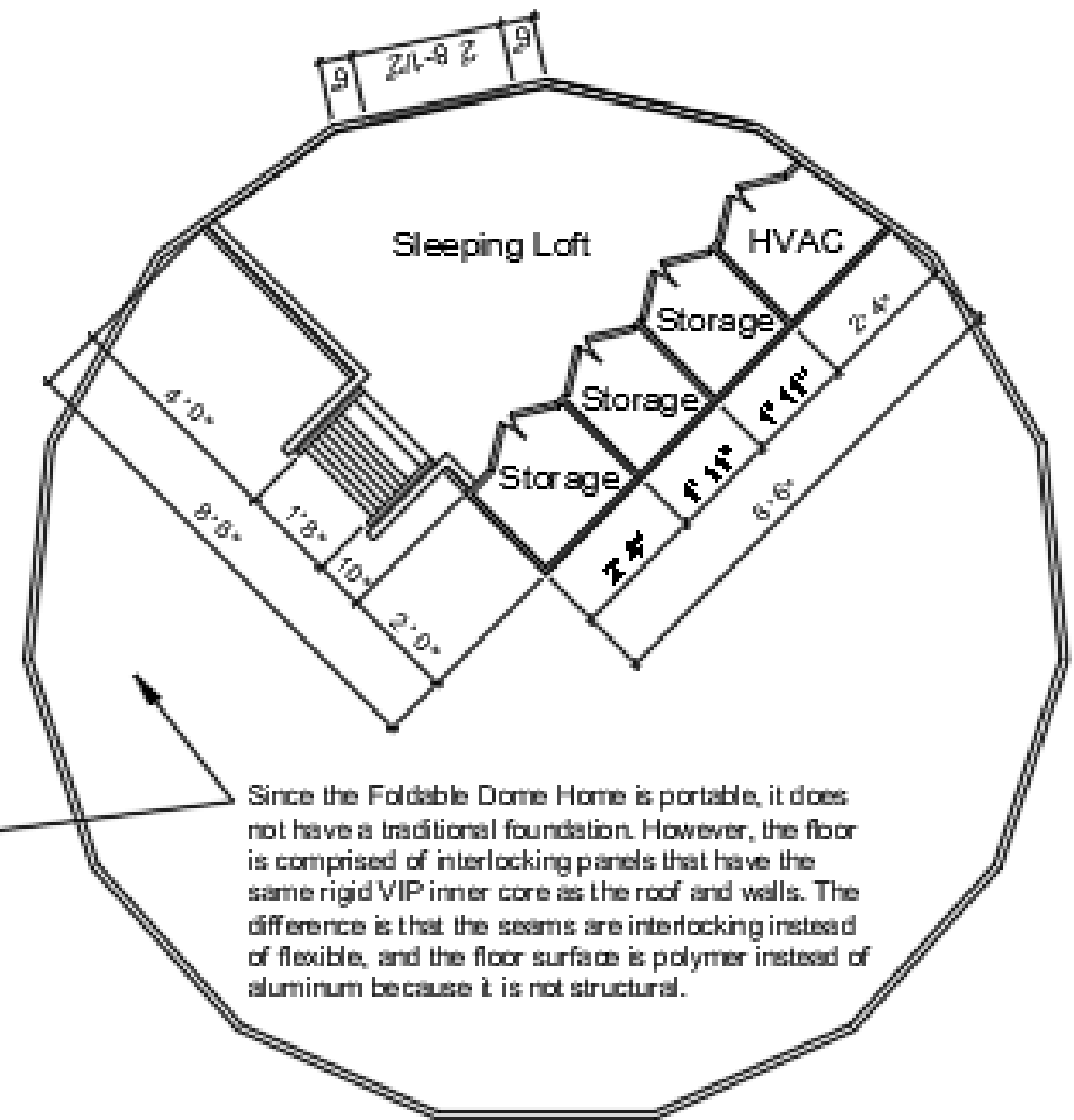
## Sectional Detail

Scale:  $\frac{3}{8}'' = 1'-0''$



## Foundation Plan A

Scale:  $3/8" = 1'-0"$ , Area: 254 Sq.Ft., Diameter: 16'-0"



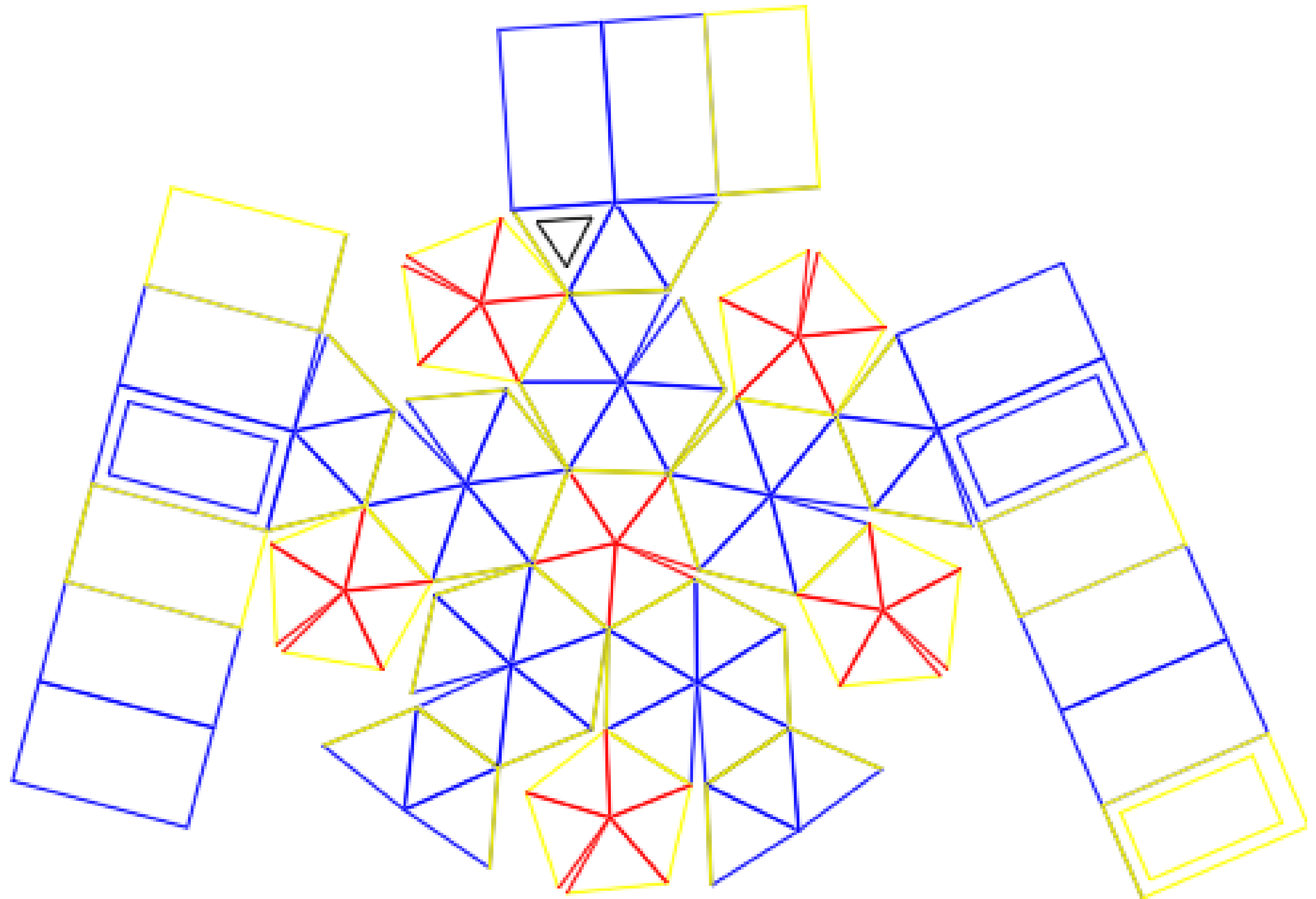
## Foundation Plan B

Scale:  $3/8" = 1'-0"$ , Area: 56 Sq.Ft."

Since the Foldable Dome Home is portable, it does not have a traditional foundation. However, the floor is comprised of interlocking panels that have the same rigid VIP inner core as the roof and walls. The difference is that the seams are interlocking instead of flexible, and the floor surface is polymer instead of aluminum because it is not structural.

## Assembly Instructions

1. Take all of the triangles out of the service core's bathroom.
2. Take all of the rectangles off of the service core's sleeping loft.
3. Assemble the floor panels and position the service core on top of the floor as shown in the Floor Plan.
4. Using the enclosed fasteners, attach the blue sides of all rectangles to each other, then attach the yellow sides of all rectangles to each other, making sure to follow a two-blue-to-one-yellow pattern as shown in the Assembly Plan. Position the two blue rectangles with a window, and one yellow rectangle with a door as shown in the Assembly Plan. During this process, attach the bottom of the rectangles with a blue bottom to the floor's blue edges, and attach the bottom of the rectangles with a yellow bottom to the floor's yellow edges, as shown in the Assembly Plan.
5. Using the enclosed fasteners, attach the blue side of a blue triangle to the top of each blue rectangle, then attach the yellow side of a red triangle to the top of each yellow rectangle, as shown in the Assembly Plan.
6. Working your way up the dome, attach the red sides of the triangles to each other (making sure that the red corners are adjacent to each other), then attach the blue sides of the triangles to each other (making sure that the blue corners are adjacent to each other), then attach the yellow sides of the triangles to each other, as shown in the Assembly Plan.



## Assembly Plan

Scale: 3/16" = 1'-0"

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**Foldable Dome Home V2**

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**2022**