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## 5. Timber Dome for Multipurpose Facility, Flagstaff, Arizona (USA)

*Owner: Northern Arizona University, Flagstaff, Arizona*
*Architect: Rossman & Partners, Phoenix, Arizona*
*Engineer: John K. Parsons, Phoenix, Arizona*
*Contractor: Mardian Construction Company, Phoenix, Arizona*
*Varax Dome Designer: Western Wood Structures, Inc.*
*Beaverton, Oregon*

*Building Dimensions and Arrangements:*
*Dome Diameter: 153 m*
*Dome Rise: 43.3 m from Play Floor*
*Depth Below Ground: 9.8 m*
*Total covered surface: 18,395 m2*
*Total Floor surface: 25,270 m2*
*Play Floor area: 9,520 m2*
*Seating: 15.200 permanent seats. Can be expanded to 18.000, 2.000 temporary end zone seats can increase capacity to 20.000.*
*Lighting: 96.000 candle power*
*Facilities: Artificial turf Soccer Field, (Football), professional size ice rink (will be covered by artificial turf during football season). 10 Basketball or 8 tennis courts (2 to 4 courts not available when ice rink in use). Five lane 322 m track with 6 lane 100 m straightways.*

*Material Used:*
*Excavation: 84,150 m3*
*Concrete: 4,590 m3 (Less Precast Seating)*
*Glue Laminated Timber: 2,200 m3*
*51cm Wood Roof Deck: 1,460 m3*

*Work Duration: 24 months*
*Service Date: September, 1977*

### Introduction

A desire and need does exist among cities and universities to provide enclosed facilities for ever larger crowds at sport contest. Yet today there are fewer than a dozen covered stadiums in the U.S.A. large enough for a football (soccer) game. The combination of high construction cost and completion times that overrun contract dates have convinced many planners that large covered multipurpose buildings are not practical. The board of regents for the university of Arizona have changed that thinking with their northern Arizona university ensphere. This building was contracted for $ 8.3 million dollars in 1975, and completed in two years.

### Materials Selection

The structural glue laminated timber dome cost much less than comparable steel or aluminium systems, and the Varax dome was selected because it offered 1/5 more space under cover at significantly lower annual operating costs than a flexible fiberglass air supported cover. The Varax dome is easy to climate control because semi-rigid insulation is applied to exposed face of the 51 cm wood roof deck.This single material provided an acceptable R insulation factor, a 0.65 noise control coefficient and a 25 flame spread rating. In addition, the white vinyl face saved the cost of painting, and provided a light reflective ceiling.

### Varax Dome Design

The Varax dome is a true spherical framework of curved glulam ribs on intermeshing great circle arcs, with a 118.6 m radius. The curved glulam ribs form triangles, which are connected by 127 unique patented steel hubs that transfer moments to create similar moments of inertia at every point in the system. Each triangle contains simple span curved purlins, set on 2.4 m centres.

The 51 mm thick tongue and groove wood deck used as roof sheating was covered on the interior side with 76.5 mm thick semi-rigid insulation.

The Varax dome was designed for 195.3 kg/m2 snow load; 85 kg/m2 actual dead load and 183.1 kg/m2 wind load. Asymmetric hanging loads, consisting of 4.9 x 18.3 m press box platform and two lighting catwalks, were added. A total 15 elementary loadings and 25 combined loading sets were investigated to determine the loading combination that produced critical design stresses.

The dome springs $40^{\circ}\ 18'\ 32''$ from 36 concrete buttresses which are 1.53 m high. Horizontal thrusts are resisted by a cast-in-place post tensioned concrete ring beam, 481.6 m in circumference.

### Erection

All glue connected materials were plant fabricated to exacting tolerances, and field assembled into triangular units. These triangular assemblies, usually two or three main grid members with purlins, were lifted by a single crane. Two other cranes were used to lift workmen in cages, to bolt-up the steel hub connections. The hub connections are designed as self supporting, so support scaffolding was not required. A gin pole is used only to provide a means of jacking members to line up bolt holes.

Hub elevations were monitored on a regular basis, and the glulam fabrication was so accurate that the final member slipped easily into place and the bolts were hand inserted.

*(M.R. Turner)*