Emmett High School – Emmett, ID

Facility: Emmett High School

Architect: Sundberg and Associates

Engineer: Dr. Arnold Wilson

Builder: Monolithic Constructors, Inc.

Description: High school consisting of five domes for a total of 110,000 square feet. One 180' diameter dome gymnasium. Two 180' diameter domes with classrooms, commons with a 5 story atrium and a 25' diameter artificial skylight, library. The three smaller domes house shop classes. 900 Students.

Owner: Emmett School District

Location: Emmett, Idaho

Constructed: 1986 - 1987

Classroom and Gymnasium Domes

COURTESY OF DOME TECHNOLOGY

The Monolithic Domes offered Emmett a reasonably priced, authentically unique alternative. In addition, the dome design provided savings in both maintenance and utility costs. Their ten-year history proved that the domes had lived up to their promises. In 1996 energy costs were less that $0.10 per square foot as compared to a local elementary school which cost $0.33 per square foot during the same time period to heat and cool.

DAVID SOUTH JR

Computer Lab

DAVID SOUTH JR

Atrium

Vice-principal Tony Villanueva says, "It's a very quiet building, when you compare it to anything else in our district. You come in and see the foyer, and it really looks like you're entering a mall.

Classrooms in the domes, he says, are bigger than those in other, "normal" structures, which has proved to be enormously advantageous. One of the frequent misconceptions about the domes centers around this issue in particular. Most people assume, because of the curvature of the outside construction, that the building encloses a considerable amount of unusable, wasted space. Villanueva says that this is just not so. "We got more space out of the building than we thought we were going to have."

"We got more space out of the building than we thought we were going to have."

Three floors of classrooms surround a five-story tall atrium. A 25 foot diameter artificial skylight provides a daylight atmosphere during all weather conditions.

The double-wide gym can seat 3,000 for graduation ceremonies. The dome also houses a weight room, wrestling room, locker rooms, offices, concessions, and a little 350 seat theater.

COURTESY OF DOME TECHNOLOGY

Gymnasium

Grand Meadow School – Grand Meadow, MN

Facility: Grand Meadow School

Architect: TSP One, Architects

Engineer: Dr. Arnold Wilson and Al Hiniker

Builder: E & V Consultants and Dome Technology

Description: School consisting of five domes, each 130' diameter for a total of 81,000 square feet. Houses K-12, 450 students.

TSP ONE

Horizontal lines unify the Domes.

Dome 1 - High School
Dome 2 - Administrative and media center
Dome 3 - Kindergarten through Grade 6
Dome 4 - Gymnasium
Dome 5 - Cafetorium, Stage, Shop, Additional Classrooms

Owner: Grand Meadow School District

Location: Grand Meadow, Minnesota

Cost: $12 Million ($90 per square foot)

Started: July 11, 2001

Completed: November 10, 2002

TSP ONE

Classroom

BRUCE KLAEHN

Gymnasium

BRUCE KLAEHN

Wrestling Room

Three factors led to the initial choice for Monolithic Domes: lower construction costs, lower operating costs and increased safety. Superintendent Bruce Klaehn said, "We passed that information on to our board and task force, and we held public meetings. The students are very excited. They feel like they're in on a ground floor, a cutting-edge event."

Both elementary and high school domes are designed with classrooms surrounding large, open, carpeted activity areas that can accommodate several groups doing different things, simultaneously.

Grand Meadow's gymnasium features pull-out bleachers, locker rooms, a regulation size basketball court and two cross-court practice goals.

The wrestling room and a separate weight room are located behind the bleachers.

When asked if teaching in the round makes a difference in how she teaches, fifth grade teacher Judy Thumann said, "Having that central activity area certainly does. We're able to schedule more activities where you need to spread out. I think, for all of us, it's opened up what we can do." Their old classrooms, she said, were just too cramped, especially for large classes such as hers, with 25 students.

TSP ONE

Commons Area

Bishop Nevins Academy – Sarasota, FL

Facility: Bishop Nevins Academy

Architect: Rafael Moreu

Engineer: John Miller

Builder: D. E. Murphy Constructors, Inc. and Domtec International

Description: Dual school — St. Martha Catholic School and Dreams are Free.

Dome A: Central core is the chapel, the Wren Pavilion. In addition to the chapel, the 128' diameter dome has administrative offices, computer labs and a library on its ground floor and classrooms.

Dome B: St. Martha's School—pre kindergarten through eighth grade. 140 feet in diameter, classroom dome.

Dome E: 124' diameter classroom dome.

Dome F: Dreams are Free — a non-graded school with programs for special-needs children, six to fifteen years old. 124 feet in diameter. 11,500 square feet of flexible class space. The Dome's modern kitchen serves as a cafeteria for both schools.

Domes C, D and G: Two Domes with diameters of 124 feet for classrooms and one Dome with a diameter of 148 feet as a gymnasium, should see completion during Phase III.

The center Mall is 300 feet long and 50 feet wide. The mall functions as a gathering area and connects all of the domes.

Owner: Catholic Diocese of Venice, Florida

Pastor: Father Fausto Stampiglia

Location: Sarasota, Florida

Cost: $12.8 Million

Started: December 2000

Completed: January 2002

COURTESY OF RAFAEL MOREU

Aerial Photo

Home-ec Classroom

Dreams are Free Commons Area

INTERIOR PHOTOS BY DAVID SOUTH JR

Elementary Classroom

Texhoma School District — Texhoma, OK

Facility: Texhoma School

Architect: Frederick Crandall

Engineer: Dr. Arnold Wilson

Builder: Monolithic Construction Management and Dome Technology

Description: Two Monolithic Domes: 108' and 66' diameter, connected with conventional construction, for a total of 18,000 square feet. 426 students.

Owner: Texhoma School District

Location: Texhoma, Oklahoma

Cost: $1.5 million ($80 per square foot)

Started: April 2000

Completed: October 2001

Library

"The initial factor that caught my attention was the cost per square foot," Superintendent Rick Kibbe said. "Then we began really researching and learned about the storm factor. We do not have a facility here for protection from a tornado, so that became very attractive."

"The initial factor that caught my attention was the cost per square foot."

Aerial View

Originally, Texhoma planned the second floor of the 108' dome to be a library at a later date. However, with the money saved in other areas of construction, they were able to finish the library at the same time as the rest of the buildings, complete wi furniture, carpeting and acoustical ceiling with seven pewer chandeliers. The school was excited to be able to add this particular finishing touch.

Overhead florescent lighting and large windows give the cafeteria a light and airy atmosphere. Student artwork adorns the wall of the cafeteria.

Texhoma School

The previous cafeteria was in the basement of the old school. School officials say the wide, open and brightly lit space has changed the kids' behavior during lunch. The cafeteria doubles as a community disaster shelter.

PHOTOS BY DAVID SOUTH JR

Lunchroom / Commons

Mountain Meadows Primary School — Arizona

Facility: Mountain Meadows Primary School

Architect: Shill, Judd, Richards and Johnson, Architects

Engineer: Robert Hatch and Brad Crane

Builder: Dome Technology

Description: Two domes with connector - 160' and 80'. Used by Red Cross during Rodeo/ Chediski Fire from June 18 to July 7, 2002.

Owner: Heber-Overgaard Unified School District

Location: Between Heber and Overgaard, Arizona

Completed: January 1999

"Basically, what drove us was economics," says Superintendent Ron Squire, when asked why the Heber-Overgaard Unified School District in Arizona chose Monolithic Domes for their new Preschool to Grade Three facility.

Squire then explains that driven by economics does not mean that they were looking for cheap. "We wanted quality, and we wanted the most building we could get for our dollar," he adds.

They dubbed their smaller dome (80' diameter) the cafetorium because it includes the cafeteria, auditorium and kitchen. Colorful hangings in the cafetorium provide excellent acoustical control.

The first floor of the larger (160' diameter), two-story dome houses classrooms, a media center, offices, areas for Special Education, the Preschool, a Nurse's Station and a staff lounge.

Classroom

Cafetorium

PHOTOS COURTESY OF DOME TECHNOLOGY

Pattonsburg Schools — Pattonsburg, MO

Facility: Pattonsburg School

Architect: Joseph Cheesebrough

Engineer: Robert Hatch and Brad Crane

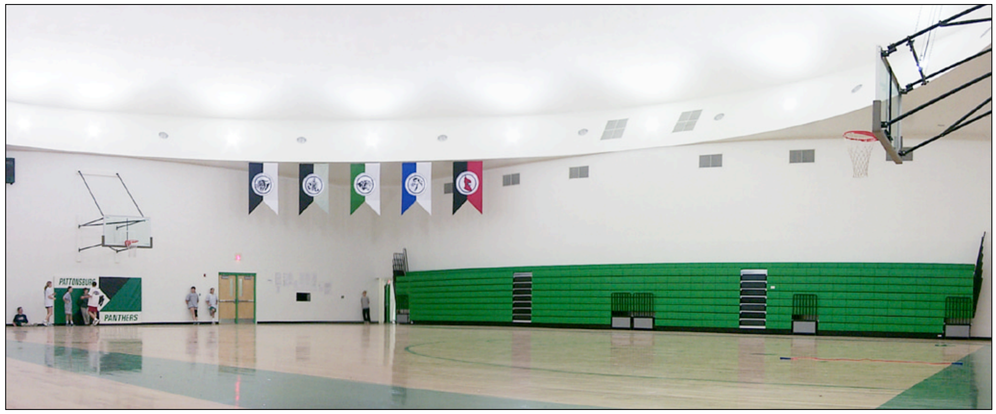
Builder: Dome Technology

Description: Four domes: 150’ gymnasium and three 110’ domes. 200 students. K-12. Built due to flooding of the Grand River and later a fire in the school.

Owner: Pattonsburg School District

Location: Pattonsburg, Missouri

Completed: 1998



Gymnasium

After having their town devastated by a flood and fire, Pattonsburg wanted the security a Monolithic Dome provides.

“We put the gym in the center purposely,” Superintendent Gene Walker says. “This creates a definite separation between the elementary and high school facilities. Additionally, that dome contains the gym, the band room and the art room. We wanted these areas conveniently located for all the students and teachers.”

“When the domes were first opened,” English teacher Ellen Pedersen says, “some people and visitors worried about working and spending the day in a windowsless environment. It’s just not a problem. It doesn’t bother us at all. No one even talks about it anymore.”

Inside High School Dome

Walker agrees, “We were very cost conscious. Every window increases costs. So instead, we put eight-foot skylights in each of the small domes and laid out the classrooms like pie wedges. Each room has a window that faces into the light of that center area beneath the skylight.”

After having their little town devastated by a flood and fire, Pattonsburg wanted the security a Monolithic Dome provides and officially designated their new school as the community’s disaster shelter.

Walker said that the Monolithic Domes, their internal design and their layout, provide significant security advantages, as well as the operational efficiency that every school wants.

PHOTOS BY DAVID SOUTH JR

Pattonsburg School

Tolchii Kooh Charter Schools — Leupp, AZ

Facility: Little Singer Community School and Leupp Library

Architect: Frederick Crandall

Engineer: Jason South and Brad Crane

Builder: Dome Technology

Description: Little Singer — 120' diameter, multipurpose center complete with elevated running track. 300 students

Leupp Library — 80' x 24' - 5026 square feet. K-12. 421 students. Already serving as both the school and the town library, this dome also functions as the town meeting hall.

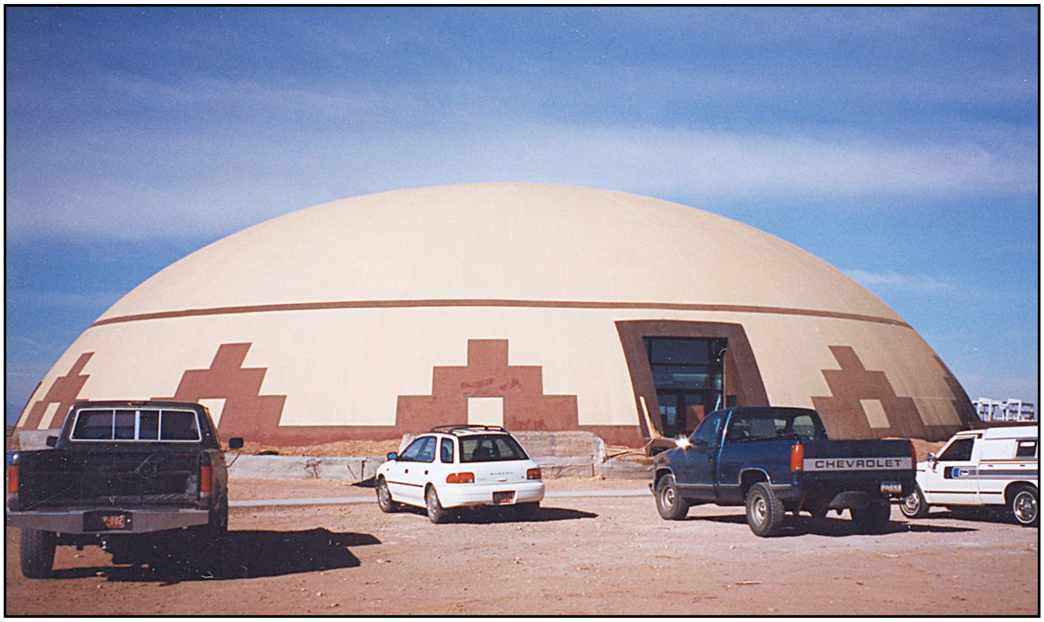
Owner: Navajo

Location: Navajo Indian Reservation, Arizona

Cost: Little Singer — $450,000 ($41 per square foot)

Leupp Library — $310,000 ($62 per square foot)

Construction: 1995 - 1997



PHOTOS COURTESY OF RICK CRANDALL

Little Singer Community School

Little Singer

Completed in the fall of 1997, its Monolithic Dome dramatically expanded Little Singer's Elementary School. The dome or Multipurpose Building has a diameter of 120 feet. Its center is a high-school-sized basketball court and gymnasium, with bleachers for 300 people.

This main floor also accommodates classrooms, community rooms, bathrooms, and offices. On the upper level, a running track circles behind the bleachers and above the offices and classes.

Leupp Library

"The students really like the library," Ron White, Assistant Superintendent of Tolchii Kooh, says. "It's so roomy and quiet. The eight-foot skylight at the dome's top gives a feeling of openness and light, but outside noise simply does not penetrate into the dome."

Gymnasium

A circle is an important Navaho symbol of completeness—an entity without beginning or end. The dome was also perfect because of Leupp's chronic high winds.

History

The school's history reaches back to the 1970s and a Navaho Medicine Man called Little Singer. Superintendent Dr. Mark Sorenson explained the name: "Navaho healers are singers and chanters and this particular one was of short stature, so people dubbed him Little Singer."

The Medicine Man noticed that children were missing from the community because they were at boarding schools. Little Singer decided that "this was not right" because the absence of children created an "unnatural silence," so he took his concern to the community who agreed.

On its own, the community began building a school. It then received a small grant from a Hollywood actress who insisted on remaining anonymous and some Federal money. In 1978, the school became incorporated. Little Singer had died by then, but the school was named in his memory.

Leupp Library

Cradleboard Elementary — Whiteriver, AZ

Facility: Cradleboard Elementary

Architect: Frederick Crandall and Spragins & Hinshaw Architects, Inc.

Engineer: Robert Hatch and Brad Crane

Builder: Dome Technology

Description: Three 110' domes for a total of 34,000 square feet, 300 students grades K-5. Features Native American motifs.

Owner: Whiteriver Unified School District

Location: Whiteriver, Arizona

Cost: $79 per square foot. Total $2.7 million

Construction: 1997 - 1998

Cradleboard's three Monolithic Domes sit nestled among Ponderosa Pines at an elevation of 7000 feet on the Apache Reservation in Arizona's High Country.

The 34,000 square foot, three dome Cradleboard Elementary serves 300 students from Kindergarten to grade five. A Native American motif is found throughout the school.

The media center is in the middle of one dome. It has an eight-foot skylight and is surrounded by classrooms. Windows in each classroom allow natural light in from the media center. Another dome also has an eight-foot skylight and a round theater/commons area for its core, encircled by classrooms.

The multipurpose dome, with its cafeteria, gymnasium, art and music areas, is flanked on either side by the domes divided into individual classrooms.

"It's a perfect location," said John Clark, Superintendent of schools. "The buildings fitting so well into our setting helped us decide to go with domes." Principal Barbara Nolan states, "A dome automatically creates an interesting learning space for children."

Cradleboard Elementary

PHOTOS BY STEVEN CUTTER

Multipurpose Dome

Media Center

Frontier Elementary School — Payson, AZ

Architect: Frederick Crandall

Builder: Dome Technology

Engineer: Robert Hatch and Brad Crane

Description: The Frontier School is three 120' diameter domes. The media center and cafeteria are the central cores of two of the domes. The cores are surrounded by classrooms. The third dome is a multipurpose center

Owner: Payson School District

Location: Payson, Arizona

Cost: $2.6 million ($67 per square foot)

Started: 1995

Completed: 1996

At first, some residents of Payson were skeptical about a domed school. Less than a year later a new attitude prevailed.

"Yes, it's an unusual building," said Sue Myers, Superintendent, "but teachers, parents and just about everyone who spends time inside these domes comes away with a positive impression."

All three domes have their own skylight and are connected to a flat roofed building that houses the school office, restrooms, and more.

The flat building is the only part of the school with windows, but teacher Deb Jones said that's not a problem.

"From the outside you see that there aren't any windows, but from the inside you don't notice it." She said, adding, "And I'm a real window person."

The circular design within each dome and among the domes is much more cohesive than in traditional long, narrow buildings, Myers said, "I can personally be in any room in less than a minute. Plus, the closeness builds a sense of community and it's easier to be collegial."


STEVEN CUTTER

Media Center


DOME TECHNOLOGY

Aerial


STEVEN CUTTER

Frontier Elementary

El Centro de la Familia — Genola, UT

Facility: El Centro de la Familia — a Migrant Head Start Program

Architect: Leland Gray

Engineer: Jason South

Builder: Dome Technology

Description: Pre-school facility consisting of a 101' dome and a 60' recreation center. All entryways and openings are inset. Designed with hieroglyphics in the concrete. Facility serves 50 Children.

Location: Genola, Utah

Completed: September 2002

Less than a thousand people now live in Genola, and most own diary farms or fruit orchards.

They depend heavily on field workers. The majority are Hispanic migrant workers who travel with their families.

The large dome, 101'x31', houses classrooms, offices, a nurse's station, an observation area, a reception area and bathrooms.

An activity dome, 60'x23', has a balcony overlooking the recreational area.

Two towerlike domes, each measuring 30'x15' and built on 17' stemwalls, provide a kitchen, cafeteria and resource center.

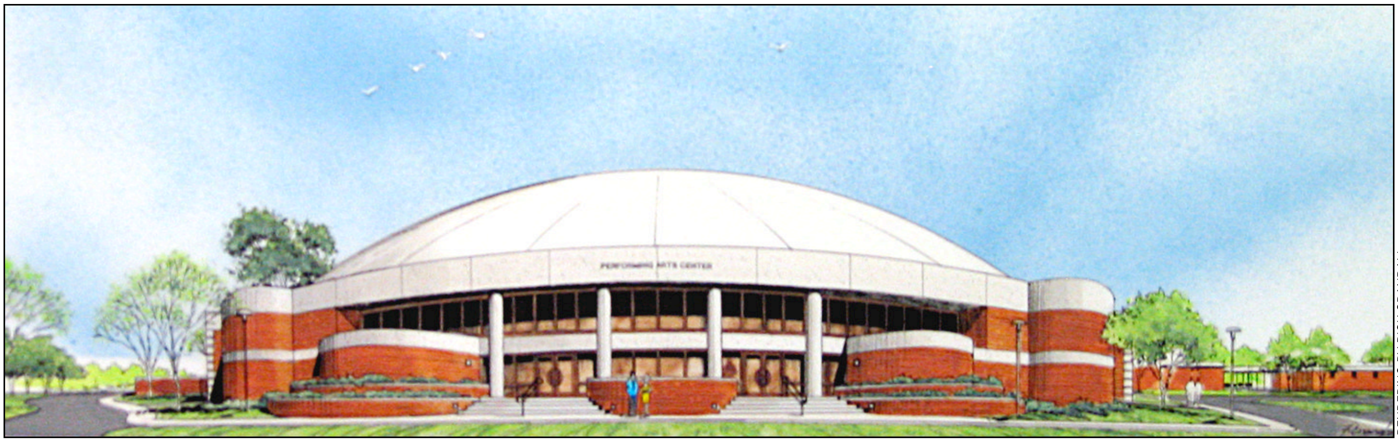
Play Dome

PHOTOS BY ANDREW SOUTH

Double Activity Towers

Genola Head Start

Performing Arts Center — Gainesville, TX



RENDERING BY RICK CRANDALL

Facility: Performing Arts Center

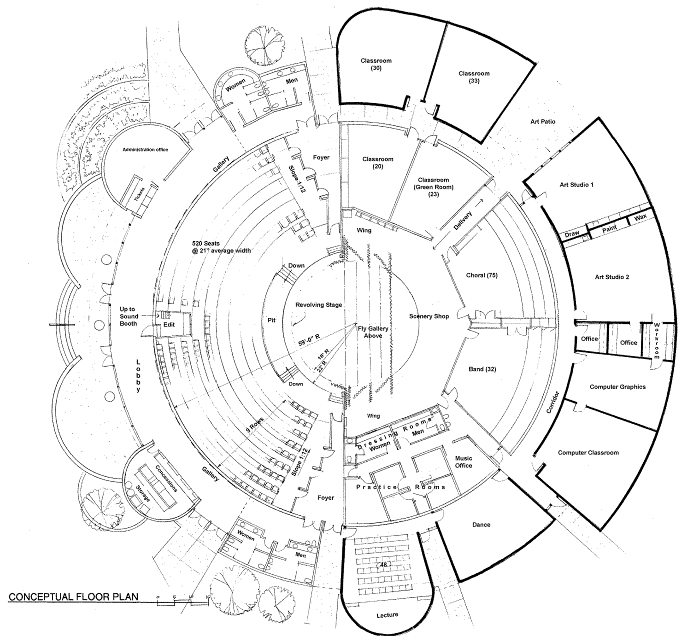
Architect: Frederick Crandall

Description: A true performing arts center complete with rotating stage, drama room, practice rooms, set storage, classrooms, green room and more. 700-seat auditorium. The dome is 130' in diameter and 41' tall.

Owner: North Central Texas College

Location: Gainesville, Texas

Construction: To begin late 2003 or early 2004



School of Communication Arts — Raleigh, NC

Facility: School of Communication Arts

Architect: Frederick Crandall

Engineer: Chris Zweifel

Builder: Centurion Builders and Dome Technology

Description: Computer animation technology school consisting of three 120' diameter domes. Each dome is about 12,000 square feet. 350 students

Two of the domes house digital animation, media and administration. The other is for digital filmmaking programing and includes a 200-foot, high-definition digital theater, soundstage, mixing stage and an editing and audio suite.

Location: Raleigh, North Carolina

Started: February 2003

RENDERING BY RICK CRANDALL

Kihei High School — Kihei, HI

Facility: Proposed Kihei High School

Architect: Leland Gray

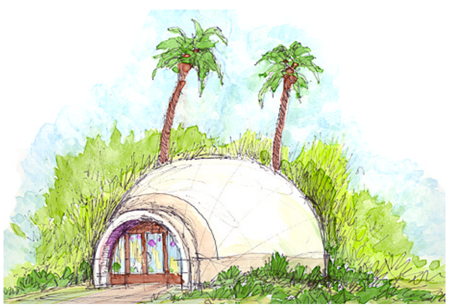
Description: School consists of an open campus of 64 Monolithic Domes. Many are individual classrooms. Others are for administration, media center, cafeteria, gym and arts center.

Location: Kihei, Hawaii on the Island of Maui

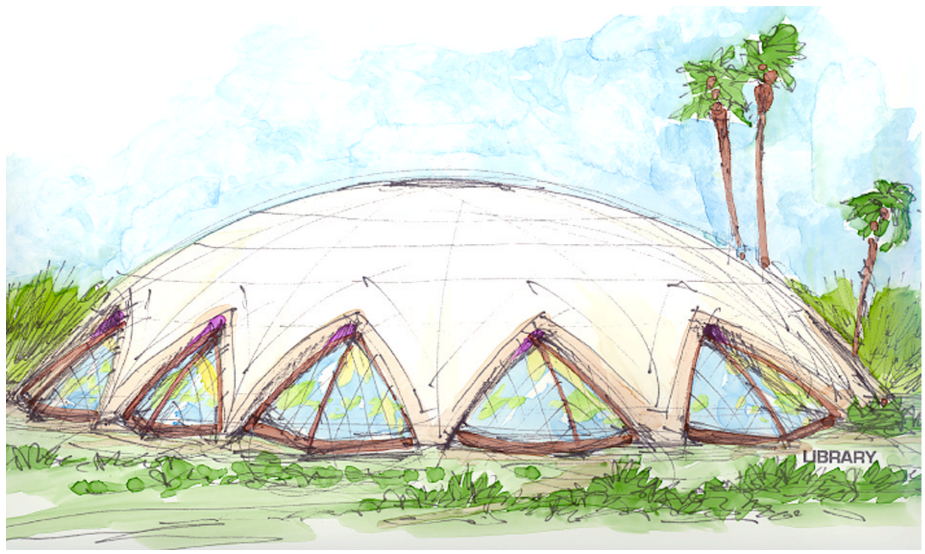
Cluster of Classrooms

Auditorium

Administration Center



Classroom unit



Library

Class **Administration** **Cafeteria** **Library** **Gymnasium** **Arts**

RENDERINGS BY LELAND GRAY

Avalon Multipurpose Center — Avalon, TX

Avalon Multipurpose Center

Facility: Avalon Gym and Multi-purpose Center

Architect: Frederick Crandall

Engineer: Dr. Arnold Wilson

Builder: Monolithic Construction Management, Monolithic Constructors, and Dome Technology

Description: 124' x 25' dome on a 12' stemwall - 11,500 square feet. Copper color dome. Came in under budget and on time. Approved by FEMA for protection from storms. 720 seats.

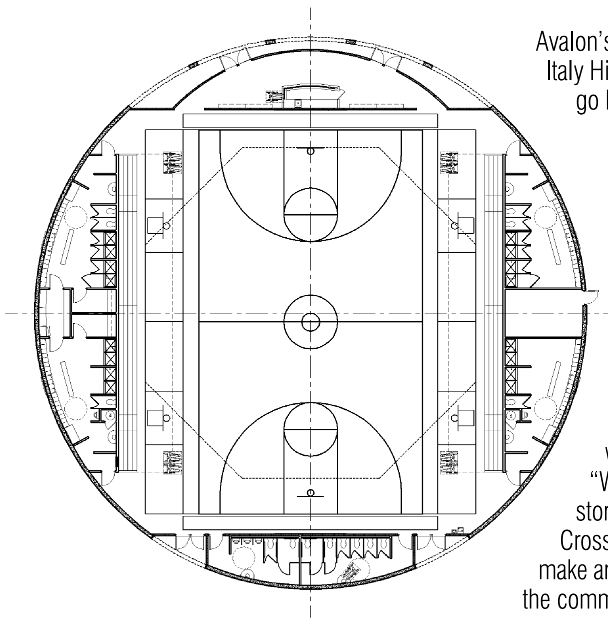
Owner: Avalon Independent School District

Location: Avalon, Texas

Cost: $1.2 Million - $110 per square foot

Started: January 2002

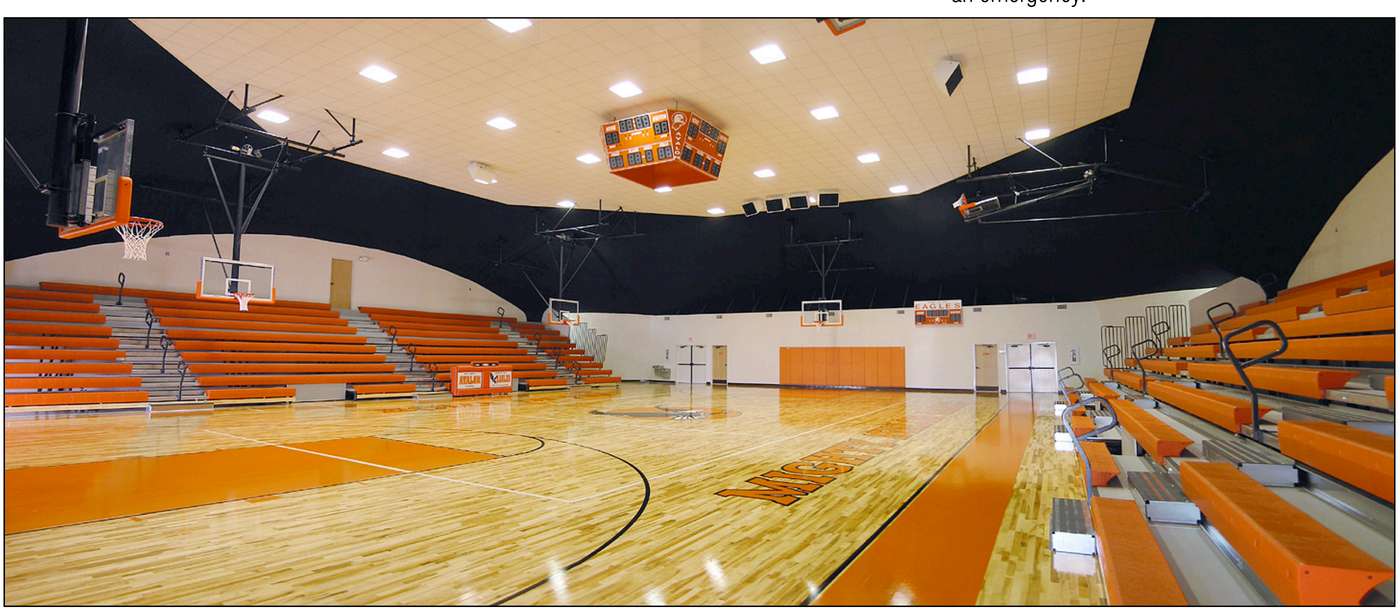
Completed: January 2003



Avalon's nearness to and familiarity with the Italy High School Gym made the decision to go Monolithic fairly easy.

School Superintendent David Del Bosque said, "We went over and really looked at Italy. And we were really impressed with what the long-term savings would be -- utilities, maintenance and that kind of thing. I personally was concerned about safety for students: the stability of the building in case of a storm."

"This is the safest structure anywhere here," Del Bosque continued. "We plan to use it also as a community storm shelter. We'll contact the Red Cross, get it certified as a shelter, and make arrangements for somebody here in the community to have a key to open it up in an emergency."



PHOTOS BY DAVID SOUTH JR

Gymnasium

Gladiator Coliseum — Italy, TX

Facility: Italy High School Multi-purpose Center

Architect: Frederick Crandall

Engineer: Dr. Arnold Wilson

Builder: Monolithic Construction Management and Dome Technology

Description: Monolithic Dome, two-story, 148' diameter as Multipurpose Center, that includes gymnasium with walking track, seating for 1500, auditorium, classrooms for special activities and concrete parking area and drives.

Owner: Italy Independent School District

Location: Italy, Texas

Cost: $2 Million - $85 per square foot

Started: December 18, 2000

Completed: January 15, 2002

The Italy Gladiators use this Multipurpose Center for basketball and volleyball, and the general school population uses it for physical education, theatrical performances and a variety of other activities.

The gym has also been designated as the school and the community disaster shelter.

Italy High chose a high, two-story design easily identified with dome arenas, and includes two levels of seating, concession stands, ticket booths, four locker rooms, public restrooms and four coaches offices.

One of the dome's features the athletes enjoy most is its maple, parquet floor laid in the famous Boston Gardens pattern.

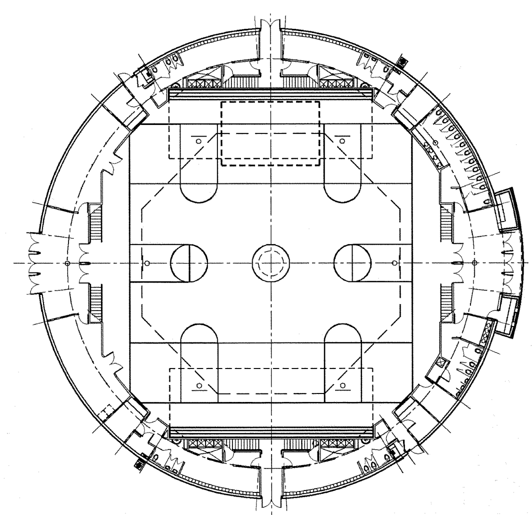
Scoreboard and hung ceiling are secured to the dome shell. Above the hung ceiling is the catwalk providing access to the sound system and HVAC systems.

Gymnasium

Italy Basketball

PHOTOS BY DAVID SOUTH JR

Italy Multipurpose Center



Payson Multipurpose Center — Payson, AZ

Facility: Payson Multi-purpose Center

Architect: Frederick Crandall

Engineer: Robert Hatch and Brad Crane

Builder: Dome Technology

Description: 200' diameter. Seats 2500 people.

Owner: Payson School District

Location: Payson, Arizona

Cost: $2.5 Million ($67 per square foot)

Started: 1995

Completed: 1996

The gymnasium is the center of the facility. The 200 foot diameter dome can seat 2,500 people.

The dome features one competition court that splits into two practice courts. There is additional space for a wrestling room, rest rooms, weight rooms, concessions, as well as four coaches' offices, two sets of boys' and girls' locker rooms and storage space.

Assistant Principal and Athletic Director Barry Smith said he is impressed by the dome's construction and floor plan. "The layout couldn't be better. They took a square gym and put it into a round building, and it is great."

District Superintendent Russ Kinzer said the new sports complex only cost about $2.8 million, as opposed to the $5 or $6 million it would have cost for a comparable building built with traditional methods.

2500 Seat Gymnasium

"The layout couldn't be better. They took a square gym and put it into a round building, and it is great."

Wrestling Room

Entry / Concessions

PHOTOS BY STEVEN CUTTER

Payson Multipurpose Center

Breckon Sports Center — Parkville, MO

Facility: Breckon Sports Center

Architect: Frederick Crandall

Engineer: Dr. Arnold Wilson

Builder: Dome Technology

Description: Twin Monolithic Dome gymnasiums, each 130' diameter. One dome provides a competition gymnasium and the other a practice gym. The entire facility encompasses 31,891 square feet and provides seating for 1,000 spectators.

Owner: Park University

Location: Parkville, Missouri

Cost: $3.4 Million (not including site development) — $107 per square foot

Started: Summer 1999

Completed: Summer 2000

Sports are a big thing at Park. The University's men's and women's teams compete in the NAIA (National Association of Intercollegiate Athletics) in basketball, volleyball, soccer and softball. The performance gym with its 1000 spectator seats — hosts competitions and special events.

Asked how he likes the domes, Athletic Director Claude English said, "Well, I'll be honest with you. There's not much at all that I dislike. The actual facility is wonderful. You always look back and think about storage and things of that nature, but the actual facility — the office space, the locker rooms, the gyms — they're all very good." According to English, he and the coaches appreciate the practice gym as much or even more than the performance gym.

He said, "We now have a facility to practice in. No more cancellations because of bad weather. It's wonderful because we have terrible winters. It's been a dream come true."

COURTESY OF PARK UNIVERSITY

Breckon Sports Center

Practice Gymnasium

INTERIOR PHOTOS BY DAVID COLLINS

Main Gymnasium

The Ultimate Sports Facility

Facility: Football Stadium

Architect: Frederick Crandall

Engineer: Dr. Arnold Wilson

Description: 400' diameter with seating for 8,000. Crenosphere technology for dome construction.

Possible Uses: As 25,000-seat stadium for ice hockey, arena football, softball, or concerts and as a convention or civic center.

RICK CRANDALL

Crenosphere Domes are huge, concrete structures ideally suited for indoor sports. Their diameters range from 300 to 1000 feet; their heights range from 75 to 500 feet. They can accommodate thousands of spectators and a virtually limitless number of activities. But—here's the best part—Crenosphere Domes are affordable and practical.

Significantly Lower Construction Costs – In some situations, the cost of building a Crenosphere could be half the construction cost of other types of sports facilities, with nothing sacrificed in playing space, spectator seating, concessions or other amenities.

Interior Design Flexibility – The Crenosphere's interior adapts readily to almost any plan. Inside the dome is just space—beautiful, open space. There are no pillars or posts—only unobstructed space. Crenospheres can be single-level or multilevel; they can include mezzanines, hanging press boxes, concession and dining areas, spectator seating and lounges, restrooms and lockers.

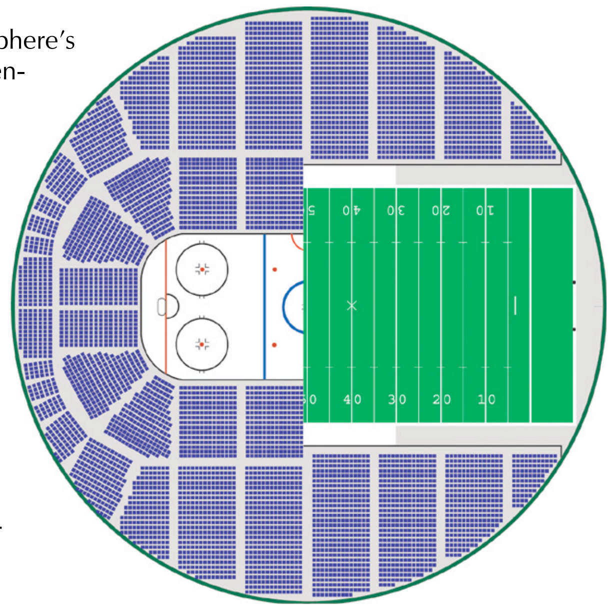
Exterior Design Flexibility – The variety of sizes and shapes make the Crenosphere ideal for football, indoor soccer, baseball, arena football, hockey, basketball, softball, tennis, and more.

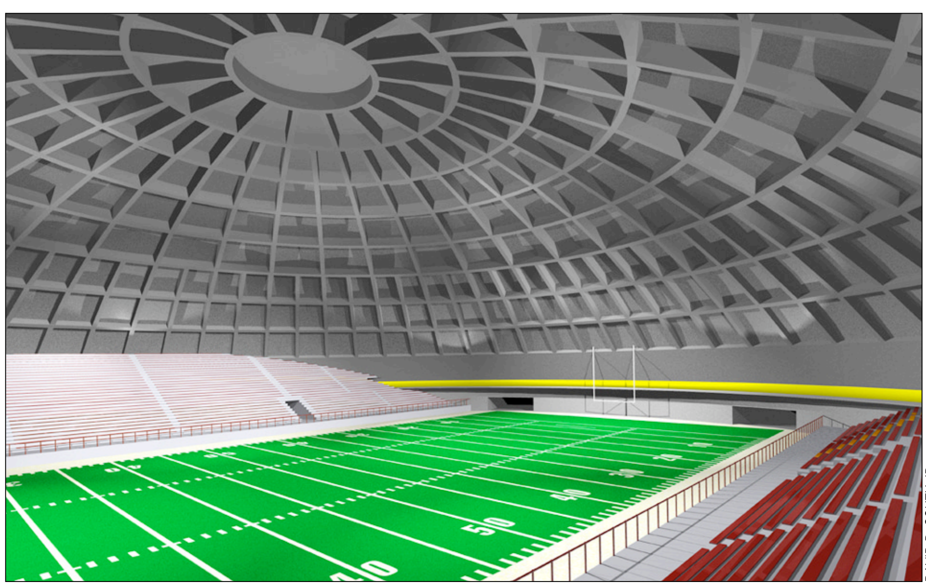
Energy Efficiency – A Crenosphere has superior insulation with an effective R-value of 60. This energy efficiency eliminates sudden changes or peaks in the Crenosphere's interior temperature and greatly reduces heating and cooling costs. What heating or cooling the dome requires can be provided by smaller or fewer units, running for shorter periods.

Cost Efficient Maintenance – The concrete and other materials used in the construction of the Crenosphere make the structure extremely durable and low maintenance.

Durability – The Crenosphere's life-span is measured in centuries, not years. It cannot burn, blow away, or be eaten by bugs. Such durability means less costly insurance premiums, and more importantly, security.

Security – A Crenosphere Dome can instantaneously become a disaster shelter and protect the population of a school or a community from the destructive force of a tornado, hurricane, or earthquake.





DAVID B. SOUTH JR.

MONOLITHIC®

Getting Your Money's Worth

The Benefits of a Monolithic Dome School

by Freda Parker

No one ever has anything like a Special Bargain Sale on schools! On the other hand, with a Monolithic Dome school you can get your money's worth. Consider the benefits:

Near-absolute Protection: FEMA (Federal Emergency Management Agency) has developed construction criteria which makes structures, built following these standards, able to provide "near-absolute protection" from injury or death caused by tornadoes and hurricanes.

Monolithic Domes meet or exceed FEMA's criteria. Tests as well as actual events have also proven the domes to be successful earthquake survivors.

In many locals, a Monolithic Dome facility is officially designated, either by the residents or by the Red Cross, as the Community Disaster Shelter.

Construction Costs: Generally, the construction of a Monolithic Dome school costs less than that of a conventional structure of a similar size. And if the conventional school is built to meet Type II Fire Resistive Codes, the Monolithic Dome which automatically meets or exceeds that code will cost significantly less.

Arizona has the greatest number of Monolithic Dome schools. There, conventional school construction prices out about 18% more than Monolithic Dome construction, and obviously, the conventional schools lack the benefit of ongoing energy savings.

But in considering costs, inflation must be kept in mind. For sometime now, construction costs have been increasing by about 9% annually. Location also makes a difference. Construction in California, the Northeast and prevailing wage states usually is costlier. The on-the-job experience of designer sand builders is yet another consideration.

Energy Savings: Dramatic differences in energy use result in dramatic ongoing savings. Because of its superior insulation—polyurethane foam sandwiched between a tough Airform and several inches of concrete — the dome needs less energy for heating and cooling. That translates into lower energy costs, less equipment for heating and cooling, and less equipment maintenance, repair and replacement.

Such savings accumulated in a bond account could equal the total cost of the facility in less than 20 years. Gene Walker, superintendent of a Monolithic Dome school in Pattonsburg, Missouri, calculated that it would take 11 years of energy cost savings to equal the price of their new school.

The DOE (Department of Energy) maintains an Energy Star Program that awards structures built to conserve energy with an E-Star Rating. Monolithic Domes have gained this rating.

In one of his articles, Ward S. Huffman, Senior Financial Specialist, Denver Regional Office, U.S. Department of Energy, wrote, "The Monolthic Dome is an idea whose time has come. It is a structure that is extremely energy efficient and sustainable without sacrificing the quality of life that we have come to expect in our homes and buildings."

Fire Safety: The Uniform Building Code, used nationally, categorizes structures based on their ability to resist fire. Type I and Type II structures, built primarily of noncombustible materials such as concrete, steel, metal and masonry are most fire-resistant. Type III, Type IV and Type V are less fire-resistant because they use combustible materials such as wood.

Monolithic Dome schools are Type II or better. Noncombustible concrete and steel — their main ingredients — make it so.

Construction Time: Once its Airform is inflated, most of the construction takes place inside the dome, unhampered by weather or daylight. Work can continue, in most instances, in rain, snow or sunshine, during the day or night, so costly delays can be avoided.

Feasibility Studies: When considering a Monolithic Dome facility, the most practical first step a school district should consider is a Feasibility Study. Commissioning a Feasibility Study, completed by Monolithic's professional designers and engineers, gives the school district a realistic preliminary program with sketches, design details and estimated costs. Based on this information, a school board can decide to accept, reject or change the plan. The school can still use a local architect for the final design and is not obligated beyond the cost of the Feasibility Study.

Insurance Costs: Invulnerability to fire, natural disaster, mold, mildew and termites makes the Monolithic Dome a low-risk structure, so insurance premiums often are significantly less than those for conventional structures.

Longevity: The lifetime of Monolithic Domes is measured in centuries. Over the years as needs change, a Monolithic Dome school may need remodeling, but not replacement. In most cases, the clear-span interior of the dome makes remodeling relatively simple.

Free Information: Free literature and answers to specific questions are readily available. Call 972-483-7423 or visit www.monolithic.com.

MONOLITHIC®

Payson Public Schools Herb Weissenfels, Supt. PO Box 919 Dist office 514 w wade Payson, AZ 85547-0919 928-474-2070 adm 928-472-20-47 fax	**Multipurpose Gymnasium** - The dome features one competition court that splits into two practice courts, as well as four coaches' offices, two sets of boys' and girls' locker rooms and storage space. It also seats 2,400. **Frontier Elementary School** – Three 120' diameter domes. One dome serves as a combination gymnasium and music room. The other two domes each have 10 classrooms along their perimeters, which surround a library and cafeteria.
Whiteriver Unified School District Neal DeWitt, Supt PO Box 190 Whiteriver, AZ 85941-0190 928-338-4842 928-338-51-24 fax	**Cradleboard Elementary School. -** The 34,000 square foot, three dome facility serves 300 students from Kindergarten to grade five.
Cibecue Community School Juan Aragon, Supt PO Box 80068 101 Main St Cibecue, AZ 85911 928-332-2591 928-332-2341 fax	**High School -** A 210 foot diameter dome high school for the Cibecue Community. The design is a split level dome with classrooms and labs on the first floor and a gym and other rooms on the second floor.
Little Singer Community Junior High School Mailing: PO Box AQ, Winslow, AZ 86047 Physical: 6.5 miles S of Birdsprings Chapter on Rte. N-71, Navajo Reservation, AZ Superintendent: Dr. Mark Sorensen 928-526-2950 928-526-8994 fax Site Contact: Lucinda Godinez 928-526-6680	Charter Facility for 7th and 8th grades. Opened 1997. The Multi-Purpose Building has a diameter of 120 feet. Its center is a high school sized basketball court and gymnasium, with bleachers for 300 people. This main floor also accommodates classrooms, community rooms, bathrooms, and offices. On the upper level, a jogging track circles behind the bleachers and above the offices and classrooms.
Tolchi' Koch Charter School, Inc Apache County PO Box 310 Winslow AZ 86047 520-526-2950	**Bird Springs Chapter House** **Leupp Library and Parent Center** located at Leupp Corner

Heber-Overgaard Unified School District Ken VanWinkle, Supt. PO Box 547 3375 Buckskin Canyon Rd Heber, AZ 85928 928-535-4622	**Mountain Meadows Elementary -** They dubbed their smaller dome (80' diameter) the cafetorium because it includes the cafeteria, auditorium and kitchen. The first floor of the larger (160' diameter), two-story dome houses classrooms, a media center, offices, and areas for Special Education, the Preschool, a Nurse's Station and a staff lounge. The second story is for later expansion.
Indian River Community College Pat Ivey 3209 Virginia Ave Fort Pierce, FL 34981 772-462-4787 772-462-4415 fax	**Planetarium** – Planetarium for the science center at the college.
St Martha's Roman Catholic Church Fausto Stampiglia, Father 200 North Orange Ave Sarasota FL 34236 941-366-4210 941-954-84-34 fax	**Bishop Nevins Academy and Dreams are Free** Four domes – The Academy has a diameter of 140 feet and classrooms for students in pre kindergarten through grade eight. Another dome, 124' diameter, with its state-of-the-art kitchen serves as a cafeteria for both schools. Dreams Are Free is a non-graded school with programs for special-needs children, six to fifteen years old, and also functions as a training center for teachers. It's dome is a structure with 11,500 square feet of flexible class space within its 124-foot diameter. A chapel is the central core of the fourth Dome (128' diameter). In addition to the chapel, this Dome has administrative offices, computer labs and a library on its ground floor and classrooms above.
Emmett High School Duane Horning, Principal 601 E 3rd St Emmett, ID 83617 208-365-6323	Built in 1986, this first Monolithic Dome **High School** serves 900 students using two 180 foot diameter Domes to house the classrooms and gymnasium. Three smaller Domes house the woodworking, metal and auto shops.
Park University Dorla Watkins, Vice President 8700 River Park Dr Parksville, MO 64152 913-967-8518x518	**Breckon Sports Events Center** – Twin gymnasiums, each 130' feet in diameter, a performance gym and a practice gym.
Ogemaw Hills Christian School Nancy Perry, Chair 2106 South Gray Rd West Branch, MI 48661 989-345-2084 989-345-2094 fax www.ogemawhills.org	**Kindergarten through 11th grade.**

Grand Meadow School District Bruce Klaehn, Supt PO Box 68 209 1st St NE Grand Meadow, MN 55936 507-754-5310 507-754-5608 fax bklaehn@gm.k12.mn.us	Five Domes that encompass classrooms, cafeteria, auditorium, gymnasium, computer lab and administrative offices. These new structures currently serve 350 students and 30 teachers in **Kindergarten through Grade 12** and include room for an additional 100 students.
Rock Port R-11 Richard Baldwin Supt. 600 Nebraska Street Rock Port, MO 64482 660-744-6294 660-744-5539 fax rbaldwin@rockport.k12.mo.us	**Technology Center** for the school. Its single floor design of 14,500 square feet includes seven labs, classrooms and a library for its 423 students and forty-five teachers.
Pattonsburg School District Ron DeShon, Supt. 504 W 4th St. Pattonsburg, MO 64670 660-367-4397x232 660-367-2111	Four Dome school for **K through 12**. The largest of the domes houses a gymnasium, stage, music, and art areas. The smaller domes hold classrooms, a library, a cafeteria, and offices.
Valley R-6 Schools Steve Yount,supt 1 Viking Dr Caledonia, MO 63631 573-779-3446 supt	**Caledonia Elementary –** two 110 diameter domes. **Multipurpose Gymnasium -** for Valley High School - seats 800
School of Communication Arts Debra Hooper Director 3220 Spring Forest Rd Raleigh, NC 27616 919-981-0972 919-981-0946 fax debra@sca3d.com http://www.sca3d.com/	**Digital Production Campus -** The three domes stand on an 11-acre site. Two of the domes house pie-shaped classrooms,and the third features a 200-foot, high-definition theater, a soundstage, a mixing stage, and an editing and audio suite for the school's digital filmmaking program. A flat-roof traditional building, which will serve as the library and administrative offices, will connect the three domes.
Mountainair School District Guy Seiler, Supt 512 Ross St Mountainair, NM 87036 505-847-2333	**Mountainair High School Gymnasium –** 110' diameter

Texhoma School District Rick Kibbe, Supt PO Box 648 418 Elm St Texhoma, OK 73949 580-423-7433 580-423-7096 rkibbe@texhoma.k12.ok.us	Two Domes, 108' and 66' diameters, house 426 students in grades five through twelve.
North Central Texas College Dr. Ronnie Glasscock, President 1525 W California St Gainesville, TX 76240 817-430-0352 x 230 rglasscock@nctc.edu http://www.nctc.cc.tx.us	**Performing Arts Center -** The 130-foot diameter dome will include a conventional theater space with seating for 400, a proscenium stage, in addition to classrooms, labs, rehearsal rooms, scene shop and other features. Expected to open January 2005.
Italy ISD Mike Clifton, Supt. 300 S College St Italy, TX 76651 972-483-7411 972-483-6152	**Gladiator Coliseum -** Monolithic Dome,two-story,148' diameter as Multipurpose Center,that includes gymnasium with walking track, seating for 1500, auditorium,classrooms for special activities and concrete parking area and drives.
Avalon ISD David Delbosque PO Box 455 104 FM 55 Avalon, TX 76623	**Multipurpose Center -** for 250 students in Pre kindergarten to Grade 12. This Monolithic Dome measures 124'x25' with a total height of 37-feet. It features seating for 720, a full-size basketball court, four locker rooms, a front foyer concession, and bathrooms.
Trinidad ISD Michael Green Supt PO Box 349 203 Eaton Trinidad, TX 75163 903-778-2415 903-778-4120 fax	**Multipurpose Gymnasium and Fieldhouse –** For K through 12. The 130' diameter Dome will seat 800. The 60' diameter fieldhouse by the football field provides restrooms and concessions. Estimated completion November 2004
Centro de la Familia de Utah Rudy Anderson 3780 South West Temple Salt Lake City, UT 84115 801-521-4473 801-521-6242 rebecca@la-familia.org Dome Location – Genola, Utah	A **Head Start Program** for babies (waddlers), toddlers and pre-kindergarten-aged children in Genola, Utah. The facility includes a 101' x 31' central dome featuring classrooms, restrooms, an observation area, nurses station, offices and reception area. A 60' x 23' activity dome features a balcony overlooking the recreational area. The two 30' x 15' domes on 17-foot stemwalls provide a kitchen, cafeteria and resource center.

MONOLITHIC DOME SCHOOLS

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The Monolithic Dome

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How To Buy a Monolithic Dome School

Consider the Benefits:

1. **Safety:** Near-absolute protection for students and staff against hurricanes, tornados, fire, earthquakes and other natural disasters. No conventional building can match this.
2. **Energy savings:** Savings of 50% or more at no premium in construction. These savings accumulated in a bond account could equal the total cost of the facility in less than 20 years. Again, unmatchable.
3. **Permanence:** -- buildings built to last for centuries with reasonable maintenance.
4. Clear span: Monolithic Domes allow for complete remodeling as needs change.
5. **Shortened construction time:** After the Airform is inflated, all work is done on the interior, unaffected by inclement weather - shortening construction time which ultimately means the building is available for occupancy sooner.

Steps to Purchase:

1. Order a Free Evaluation. This will give you a very preliminary budget.
2. Next, order a feasibility study. This step is not the norm, but beneficial to dome construction and schools in general. It provides a road map. Budgets will be established. Schedule of events will be set up. A preliminary floor plan will be provided as well as perspective of what the school will look like. **Do not underestimate the importance of this step!** Some who have tried to skip this step have had serious consequences.
3. When the feasibility study is complete and the resolve is to continue, select an architect and a construction method (i.e. general contractor, construction management, or design build.)

Related Links:

- Monolithic Domes Help Pass School Bonds
- **Superintendent of Grand Meadow ISD Produces Informational DVD**
- Printable School Information Packet [PDF]
- Thoughts on the Bidding Process for Construction of New Schools
- Monolithic Dome School Pricing-- How Much Does a Monolithic Dome School Cost?
- Making the Grade
- Bait and Switch -- What happened in Hector, Arkansas
- Free Educational Facility Project Evaluation

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Monolithic Domes Help Pass School Bonds

March 24, 2004

To date, of all the school bonds voted on which proposed a Monolithic Dome facility, all but one have passed. We think there is a direct correlation between presenting a Monolithic Dome as part of the proposal for the bond and successfully passing the bond... and here's why:

by David B. South, President of the Monolithic Dome Institute

Safety First

First and foremost, board members, parents, teachers and community members are concerned about the safety of their children, especially if the community lies in tornado and hurricane prone areas of the country. Children need to feel safe! Parents want their children safe in their absence. There is no other structure better able to protect our children during disasters such as tornadoes, hurricanes and fires than a Monolithic Dome. If an entire school is not needed in the district or afforded by a bond, building a Monolithic Dome addition or gymnasium still provides a safe refuge in case of a disaster. The safety factor alone is often enough to convince tax payers that Monolithic Domes are the way to go. If not, there are many other benefits which favorably convince voters.

Monolithic Domes Benefit Tax Payers and Educators

Citizens tire of the "same ol', same ol'." They want new and improved facilities. Therefore, proposing a Monolithic Dome strikes a great advantage.

When board members present the long list of benefits the Monolithic Dome offers, it actually becomes easier to convince voters to pass the bond. Monolithic Domes are a quantum leap forward. They are more than just cutting edge construction technology, they provide "near-absolute protection" where children are safe every day from disasters. They also provide long-term energy savings – generally equaling the cost of the building within just 20 years. Savings also come through decreased ongoing maintenance.

Many patrons were small children when the building that is being replaced was originally built. This doesn't make sense. Why not build a building that will last more than a single lifetime -- especially when they are more cost efficient than conventional short-lived buildings. People want to see more bang for their buck which is exactly what they will get by using Monolithic Dome technology.

Overcoming Obstacles

Obstacle 1: Fear

When a school district goes for a bond, board members will either have a word picture or rendering of some sort illustrating the proposed building. Board members sometimes have a fear that this could could work against them – especially if they show a dome. However, we have found that the exact opposite proves true. Community members sometimes have a suspicion that money may not be properly husbanded by the school district. This is especially true if a district attempts in anyway to hide what they intend to build. But if the district will lay all the cards on the table for the constituents to look at, show the benefits and answer questions, they have a far better chance of getting a bond passed. Citizens appreciate board members who have done their homework and show them how they will be saving money – long term.

The superintendent has a problem in that if he tries something out of the ordinary and it fails, whether it is related to the buildings or not, he could lose his job. Superintendents ride a knife edge anyway. All kinds of things can go wrong in the district that a superintendent can be blamed for.

School board members are elected by their friends to be abused by their friends for not running the school the way the friends want it run. They have the worst job in the world. They don't get paid for it, yet they are all afraid they will lose their job or get voted off. It's an interesting phenomena. Therefore, it takes a very courageous school board member to say, "Let's do this a better way."

The irony is that each one, the architect, the superintendent, and the board member will say exactly the opposite in public, but the realities are still there. Fortunately, now and then we have people in those positions with the courage to step up and say "lets make changes."

Obstacle 2: The Beauty Contest

The system of purchasing a school has evolved over the years. Typically the school board will hold what is known in the trade as a "beauty contest" to select an architect. There is no bidding at this time. The school calls for proposals from one or more architects. The responding architects, by appointment, show their portfolio of previous projects and any references are shared with the board. After consideration of the candidates, the board will select "the architect." Schools are not allowed to discuss fees until the architect has been selected.

Often the architect will be a member of the community, or even a friend of the board. After being selected the architect is expected to be the team leader and get the school built. As far as selling the board on the idea of a Monolithic Dome school, it is tough to get in the door after an architect has been selected.

This is where things go awry. It is not in the architect's best interest to try anything new. He has a contract that is based on a percent of the total dollars spent. The least amount of money that he has to spend to produce the drawings, to get the building built is in his best interest. He will often have old plans and specifications in his computer that he can adapt to the new projects. If he opts to build a Monolithic Dome, he increases his workload and has to do more homework. This takes more time for both he and his staff. It nearly doubles his work load while still getting the same final fee. In fact, if they get the building built for less, then the architect actually makes a smaller fee.

In my opinion, a school board would be better served to pay for a feasibility study from all interviewed architects. Ask each one to come up with a plan and a proposal and budget before hiring them. What an architect shows as previous project has very little to do with what needs being done now for the school.

And lastly, a piece of advice: Deal honestly and obey the law.

Public schools are scrutinized by everybody. School officials must be careful to keep all dealings out in the open and above board. Any attempts to hide things usually turns into a disaster. There are many laws and statutes to obey. Not only must they be careful how they bid and purchase but they must be certain to follow proper protocol regarding budgeting, bidding and paying.

Related Links:

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- Free Educational Facility Project Evaluation

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Building Survivability

The Monolithic Dome is the most disaster resistant building that can be built at a reasonable price without going underground or into a mountain.

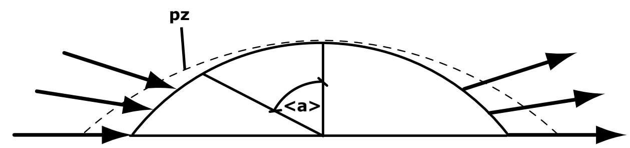
A wind of 70 miles per hour blowing against a 30 foot tall flat walled building in open flat terrain will exert a pressure of 22 pounds per square foot (see sidebars). If the wind speed is increased to 300 miles per hour the pressure is increased to 404 pounds per square foot (psf). Wind speed of 300 MPH is considered maximum for a tornado. It is far greater than that of a hurricane.

[Cars can be parked on 100 psf. The side pressure on the building could equal the weight of cars piled 4 high. No normal building can withstand that much pressure. Many Monolithic Domes are buried up to 30 feet deep. They must withstand pressures up to 1 ton per square foot (2000 psf)].

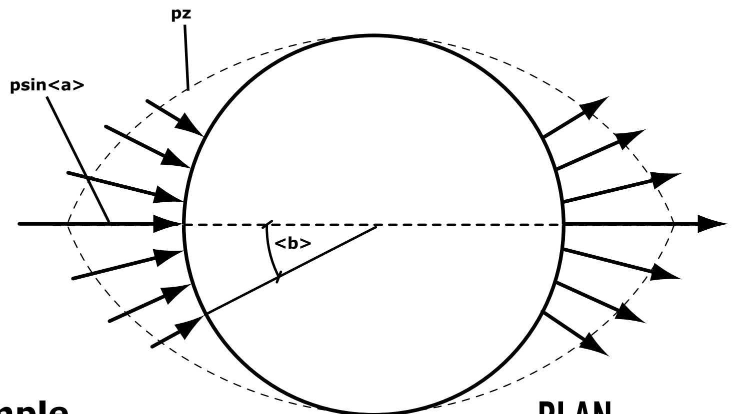
Against tornado pressure a Monolithic Dome 100 feet in diameter, 35 feet tall would still have a safety margin of nearly 1½ times its minimum design strength. In other words, the stress created by the 300 mile per hour wind would increase the compressive pressure in the concrete shell to 1,098 psi. The shell is allowed 2,394 psi using design strengths of 4,000 psi.

The fact is the Monolithic Dome is not flat and therefore never could the maximum air pressure against it of 404 pounds per square foot be realized. Neither is the concrete only 4,000 psi. It is always much greater. The margin of safety is

Concrete Dome Seismic Analysis



ELEVATION



PLAN

Example

Dome Diameter = 110’
Height of Dome = 37’
Thickness = 3” @ top and 8” @ bottom
Ref: Billington 1985 Ed., p. 55

pz = pcos<b> sin<a>
p<a> = p<b> = o

Membrane Forces

N<a>	= - apk$_1$ cos<b>
N<ab>	= - apk$_2$ sin<b>
N<b>	= - apk$_3$ cos<b>

Seismic Force (UBC 1985 Edition)

V	= ZSICKW	(Formula for the total design lateral force)
Z	= 1.0	(Zone IV — Seismic Zone Factor)
CS	= 0.14	
I	= 1.5	(Importance Factor = Hospital)
K	= 2.0	(Unusual building such as Dome — very conservative)

Therefore: V = (1.0) (1.5) (0.14) (2.0) W = 0.420W — Note: V = 0.14W for normal shear wall building!

V = (0.420) (100) = 42.0 psf (pounds/square foot) — one square foot of shell 8” thick weighs 100 lbs.

The value of p = V = 42.0 psf.

For demonstration purposes assume p = 60 psf. This represents earthquake forces in excess of the most sever code requirement by a factor of 1.4.

Maximum stress due to N<b> is -64.8 psi; N<a> is -70.6 psi. Maximum bending moment is 909.3 lbs - ft/ft.

For a vertical live load of 40 psf in addition to the dead load of the shell the following stresses and moment are obtained. Maximum stress due to N<a> = -82.5psi; N<b> = -70.7 psi or .146.5 psi. The maximum bending moment is 1,588.0 lbs-ft/ft.

The maximum allowable compressive force in the concrete is: fc = 1.33 (0.45) (4000psi) = -2.394psi. This is many times greater than the -70.6psi needed.

Conclusion

The forces caused by a major earthquake are considerably less than normal provided for when a dome is designed for nominal vertical loads.

probably more like three or four.

The Monolithic Dome at Port Arthur, Texas has now been hit by three hurricanes. A hurricane does not exert enough pressure on a dome to be even noticed. As shown above the dome can very easily withstand the stresses of a tornado.

However, debris carried by a tornado could cut the surface membrane. If the debris contained a large timber or metal object, it might be possible if conditions were just right to put a puncture into the dome. But the puncture would be very local and would certainly never cause serious collapse of the dome. Possibly damage to the doors or windows may occur if there was a rapid decompression caused by the tornado.

For most Monolithic domes the likely disaster will be earthquake. The worst areas in the United States are listed as seismic zone 4. From analysis (see "Concrete Dome Wind Analysis" sidebar) it is easy to see that earthquake forces do not even approach the design strength the Monolithic Dome is built to withstand under normal every day usage. It would take an external force many times as large as the earthquake to approach the design strength of the concrete itself.

Nuclear fallout is another disaster consideration. It is interesting to note that the only structure left standing near ground zero at Hiroshima was the concrete skeleton of a dome. Certainly the Monolithic Dome would be superior to most buildings if a nuclear fallout condition occurred. Rain would tend to wash the radiation off the building much better than conventional buildings.

Generally the Monolithic Dome is quite tall. Radiation strengths are inversely proportional to the square of the distance from the source. The roof of the Monolithic Dome would hold the radiation further from the occupants than many other structures. Also concrete itself is a good absorber of radiation. The concrete Monolithic Dome would greatly reduce the effects of fallout on the occupants.

It is interesting to note that German thin shell structures stood up to allied bombing in the second world war better than most other structures. When a bomb would hit a thin shell it would either bounce off their tough resilient exterior or it would puncture a hole through.

Since there are no single components that carry large loads, there is nothing that can be knocked down like a beam or a column. Therefore repair was a simple patch to cover the hole that was made when the bomb would go through.

"Thin Shell" is the generic name for a Monolithic Dome.

This information was compiled by Doctor Arnold Wilson, a leading engineer in thin shell concrete construction.

Wind Speed	Pressure
70 mph	**22 psf**
100 mph	**50 psf**
150 mph*	**100 psf**
300 mph**	**404 psf**

***Force 5 hurricane (worst)**
**** Force 5 tornado (worst)**

Concrete Dome Wind Analysis

Example 1

Commercial building 30 feet high in exposure C (most severe exposure in open flat terrain). Using design wind pressure from UBC 1985 Edition, section 2311.d, of 70 MPH. V = 300 MPH.

$p = C_e C_q Q_s I$
$I = 1.0$ (Commercial Building)
$Q_s = 13psf$ (pressure from wind)
$C_e = 1.3$ (building height 30 ft. - exposure C)
$C_q = 1.3$ (method 2)

Therefore p = (1.3) (1.3) (1.3psf) (1.0) = 22psf

Example 2

Assume same building and same exposure but with wind speed of 300 mph.

Preference: Finte, Mark, Handbook of Concrete Engineering; Nan Nostrand Reinhold, 1974.

$p = 1/2\ C_s C_a C_g P V_h^2 (H/h)^{2/alpha}$

Assume everything is constant except the wind speed.

$p = C V_h^2 = 22psf$ for V = 70 mph (example 1).
Therefore $C = (22) / (70)^2 = 0.00449$
Then $p = (0.00449) V_h^2$ for V = 300 mph; p = 404psf

The maximum concrete stress in dome 100 feet in diameter by 35 feet high with p = 400psf is 1,098psi compression. From the "Concrete Dome Seismic Analysis" example we see the allowable stress is significantly higher at 2,394 psi.

Conclusion

The forces caused by wind and earthquake on a concrete dome generally do not control the design. Domes are very strong and durable and in a realistic situation would probably still be standing when all conventional structures had failed.

PASSIVE SOLAR HANDBOOK

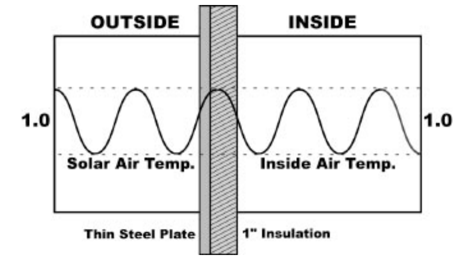
1.4 Optimal Use of Mass and Insulation

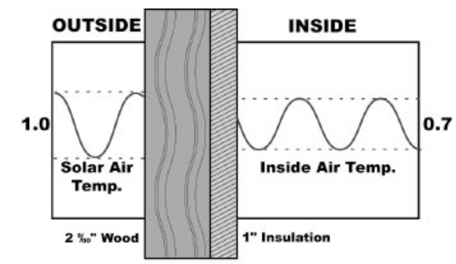
A heavy wall must have two qualities in order to dampen diurnal changes in the exterior environment relatively constant: *heat capacity* — the ability to store heat, and *low heat conductivity* — the ability to resist, or to insulate against heat flow. If one intermittently exposes an adobe brick first to a blow torch and then to cold water (and if each exposure time is relatively short) the temperature of the brick never reaches either extreme, but oscillates somewhere in between. The heat capacity of the brick keeps its temperature from rising rapidly with the small heat addition, or dropping rapidly with the small heat extraction. The brick's insulating quality prevents heat from entering or leaving very rapidly.

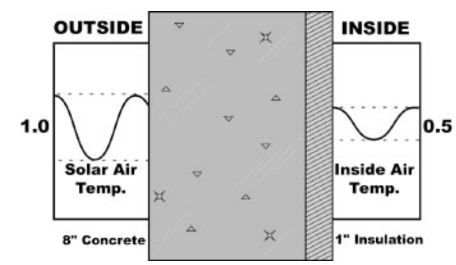
Adobe, however, does not happen to have the optimum combination of heat capacity and insulation. This problem can be resolved by the way the material is used which is as important as what material is used. The most effective way of maximizing the two qualities — eat capacity and insulation — in a building wall is to use two separate materials. Ideally, one would choose a material with little resistance to heat flow. By placing the insulating material next to the external environment, little heat is allowed into or out of the building and with the high heat capacity material next to the inside environment, what heat does enter or leave (primarily through windows and interior heat generation) cannot change the temperature of the heat capacity material rapidly. Thus, little heat is let in or out, and the high capacity material slowly stores heat. The building's thermal mass damps out temperature fluctuations.

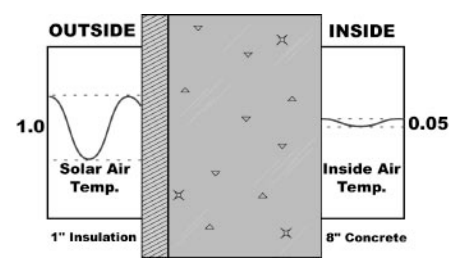
Thus a more ideal wall than adobe alone would be one made of externally insulated adobe or externally insulated concrete. This concept of externally insulated, high mass construction is common to all of the passive concepts in this handbook except those using isolated heat storage arrangements such as the rock bed thermosiphon system.

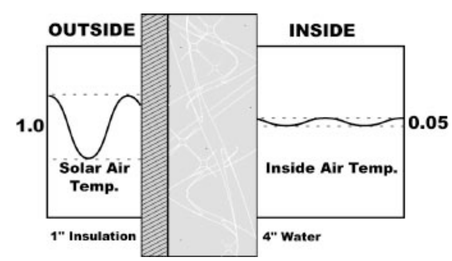
Reprinted from the California Energy Commission "Passive Solar Handbook."











"My Monolithic™ Dome buildings are saving me 75% on heating and cooling bills."

— Phillip Ricks, Owner, K-P Foods, Inc.

The Monolithic Dome may be the best engineered, best insulated and least expensive permanent building in the world today.

Though only a recent innovation, over 200 Monolithic Domes are in use across the country today. They are being used in every capacity — from warehouses to government offices, from factories to freezers, from retail stores to storage, and many homes.

Monolithic Domes are typically being built for half the cost and in half the time of comparable structures. They are often built in the middle of the winter.

In every size and capacity, owners are reporting significant savings in heating and cooling the Monolithic Dome.

K-P Foods, Inc., manufacturer of a frozen dessert product, uses a 1250 square foot Dome to store its product at -5 degrees (F). Based on refrigeration experts' opinions, the freezer should be using **four** times the 5 tons of generator power it uses.

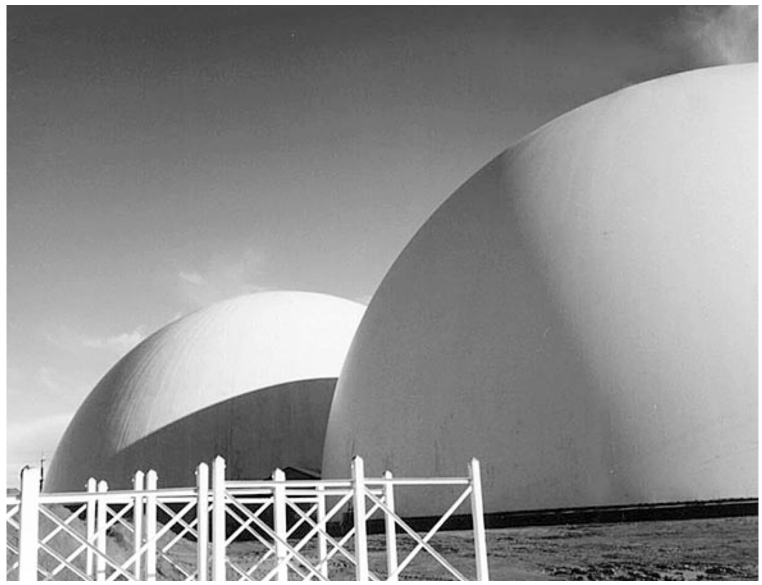
K-P's manufacturing plant, 6,350 square foot dome, is heated in winter with 120,000 BTUs of power. Experts insist the plant needs **five** times more heating power. K-P owner Phillip Ricks has substantiated his savings by comparing his electric bill with others.

To understand why the Monolithic Dome is so energy efficient, you need to know how it is built.

Construction begins by inflating a fabric form. The inside of this form is sprayed in a continuous sheet with two to five inches of polyurethane foam. A custom-designed network of steel bars is attached to the interior side of the foam and then sprayed with 2 to 6 inches of high-density concrete.

An engineering report: Why the MonolithicDome is so energy efficient:

The massive concrete shell acts as a "heat sink," storing incoming heat and releasing it slowly to reduce peak loads.



CALAMCO Cold Storage facility. Each Monolithic™ Dome is 230 feet in diameter and can store 13,000 tons of fruit — that's over 600 semi-truck loads.

Polyurethane foam has the highest insulative value of any building insulation.

Since the insulation is bonded to the **outside** of the concrete, it reduces the amount of heat being transferred into or lost from the concrete to outside conditions, thus increasing the temperature buffering effect of the concrete.

Because the urethane is sprayed in a continuous shell, there are no joints, thus eliminating leaks. The Dome is seamless and nearly air tight.

The Monolithic Dome has many other important advantages, including its great strength, durability, and resistance to fire and corrosion.

Learn more about why so many businesses are choosing the Monolithic Dome. If you'd like, we'll put you in touch with other Monolithic Dome owners.

With energy and building costs constantly rising, you really deserve to investigate further.

Energy Savings Pay For A Church

One of the major benefits to a church, school or any institution in a Monolithic Dome is the energy savings. Recently, we completed a study of a 34,000 square foot church located near Houston, Texas.

The Monolithic Dome church has been in use for more than ten years. We verified the estimated savings with the pastor. He tells us that our numbers are very conservative when comparing the energy cost for the Monolithic Dome versus the conventional building of similar size in the Houston area. The numbers presented in the chart represent:

1. The annual energy savings: They are increased 2% per year through the 30 year study. The 2% is for inflation. It is a very conservative estimate.
2. The energy fund represents the accumulation of the energy savings deposited in an investment paying interest at seven percent per annum.

The church facility cost approximately 1.2 million dollars when it was constructed. Had the energy savings been invested as shown— in the thirteenth year the fund would equal the original price of the church. And at the end of thirty years the fund would be equal to more than four times the original price of the church.

What is not shown here is the reduced cost at the time of construction of the heating and cooling equipment, as well as the overall maintenance cost for the heating and cooling system. Not only is there less cost for the heating and cooling system, there is less cost for the electrical system because it does not have to service such a large heating and cooling system.

Note: Generally, fire insurance for a Monolithic Dome will be less than half of a conventional building. These insurance savings can often be very dramatic.

Year	Annual Energy Savings	Energy Saving Fund
1	$50,000.00	$50,000.00
2	$51,000.00	$104,500.00
3	$52,020.00	$163,835.00
4	$53,060.40	$228,363.85
5	$54,121.61	$298,470.93
6	$55,204.04	$374,567.93
7	$54,308.12	$457,095.81
8	$57,434.28	$546,526.80
9	$58,582.97	$643,366.64
10	$59,754.63	$748,156.94
11	$60,949.72	$861,477.64
12	$62,168.72	$983,949.79
13	$63,412.09	$1,116,238.37
14	$64,680.33	$1,259,055.39
15	$65,973.94	$1,413,163.20
16	$67,293.42	$1,579,378.04
17	$68,639.29	$1,758,573.79
18	$70,012.07	$1,951,686.03
19	$71,412.31	$2,159,716.36
20	$72,840.56	$2,383,737.07
21	$74,297.37	$2,624,896.03
22	$75,783.32	$2,884,422.07
23	$77,298.98	$3,163,630.60
24	$78,844.96	$3,463,929.70
25	$80,421.86	$3,786,826.65
26	$82,030.30	$4,133,934.81
27	$83,670.91	$4,506,981.15
28	$85,344.32	$4,907,814.16
29	$87,051.21	$5338,412.36
30	$88,792.23	$5,800,893.46
Total:	**$2,028,403.96**	**$5,800,893.46**

"R" Fairy Tale

By David B. South

The Myth of Insulation's R-value

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"R" Fairy Tale

One of the fairy tales of our time is the "R-value." The "R-value" is touted to the American consumer to the point where it has taken a "chiseled in stone" status. The saddest part of the fairy tale is that the R-value by itself is almost a worthless number.

It is impossible to define an insulation with a single number. It is imperative we know more than a single "R" number. So why do we allow the R-value fairy tale to be perpetuated? I don't know. I don't know if anybody knows. It obviously favors fiber insulation. Consider the R-value of an insulation after it has been submersed in water or with a 20 mile per hour wind blowing through it. Obviously the R-value of fiber insulations would go to zero. Under the same conditions, the solid insulations would be largely unaffected. Again R-value numbers are "funny" numbers. They are meaningless unless we know other characteristics.

None of us would ever buy a piece of property if we knew only one dimension. Suppose someone offered a property for $10,000 dollars and told you it was a seven. You would instantly wonder if that meant seven acres, seven square feet, seven miles square, or what. You would want to know where it was — in a swamp, on a mountain, in downtown Dallas. In other words, one number cannot accurately describe anything. The use of an R-value alone is absolutely ridiculous. Yet we have Code bodies mandating R-values of 20's or 30's or 40's. A fiber insulation having an R-value of 25 placed in a house not properly sealed will allow the wind to blow through it as if there were no insulation. Maybe the R-value is accurate in the tested material in the lab, but it is not even remotely part of the real world. We must start asking for some additional dimensions to our insulation. We need to know it's resistance to air penetration, to free water, and to vapor drive. What is the R-value after it is subjected to real world conditions?

The R-value is a fictitious number supposed to indicate a material's ability to resist heat loss. It is derived by taking the "k" value of a product and dividing it into the number one. The "k" value is the actual measurement of heat transferred through a specific material.

The Test used to determine the "R" value:

The test used to produce the "k" value is an ASTM test. This ASTM test was designed by a committee to give us measurement values that hopefully would be meaningful. A major part of the problem lies in the design of the test. The test favors the fiber insulations — fiberglass, rock wool, and cellulose fiber. Very little input went into the test for the solid insulations, such as foam glass, cork, expanded polystyrene or urethane foam.

> **"Rigid urethane foam has been called "super-insulation" because, inch for inch, it provides almost one-and- a-half to three times the insulation value of other insulating materials.**
>
> **Highly resistant to water and water vapor, it retains its insulation effectiveness indefinitely."**
>
> *"Section 1", Urethane in Building, Mobay Chemical Corporation, Pittsburgh, PA*

The test does not account for air movement (wind) or any amount of moisture (water vapor). In other words, the test used to create the R-value is a test in non-real-world conditions. For instance, fiberglass is generally assigned an R-value of approximately 3.5. It will only achieve that R-value if tested in an absolute zero wind and zero moisture environment. Zero wind and zero moisture are not real-world. Our houses leak air, all our buildings leak air, and they often leak water. Water vapor from the atmosphere, showers, cooking, breathing, etc. constantly moves back and forth through the walls and ceilings. If an attic is not properly ventilated, the water vapor from inside a house will very quickly semi-saturate the insulation above the ceilings. Even small amounts of moisture will cause a dramatic drop in fiber insulation's R-value — as much as 50 percent or more.

Vapor Barriers:

We are told, with very good reason, that insulation should have a vapor barrier on the warm side. Which is the warm side of the wall of a house? Obviously, it changes from summer to winter — even from day to night. If it is 20 F below zero outside, the inside of an occupied house is certainly the warm side. During the summer months, when the sun is shining, very obviously the warm side is the outside. Sometimes the novice will try to put vapor barriers on both sides of the insulation. Vapor barriers on both sides of fiber insulation generally prove to be disastrous. It seems the vapor barriers will stop most of the moisture but not all. Small amounts of moisture will move into the fiber insulation between the two vapor barriers and be trapped. It will accumulate as the temperature swings back and forth. This accumulation can become a huge problem. We have re-insulated a number of potato storages that originally were insulated with fiberglass having a vapor barrier on both sides. Within a year or two the insulation would completely fail to insulate. The moisture would get trapped between the vapor barriers and saturate the fiberglass insulation to the point of holding buckets of water. Fiber insulation needs ventilation on one side; therefore, the vapor barrier should go on the side where it will do the most good.

We understand air penetration through the wall of the house. In some homes when the wind blows, we often can feel it. But what most people, including many engineers, do not realize is that there are very serious convection currents that occur within the fiber insulations. These convection currents rotate vast amounts of air. The air currents are not fast enough to feel or even measure with any but the most sensitive instruments. Nevertheless, the air is constantly carrying heat from the underside of the fiber pile to the top side, letting it escape. If we seal off the air movement, we generally seal in water vapor. The additional water often will condense (this now becomes a source of water for rotting of the structure). The water, as a vapor or condensation, will seriously decrease the insulation value — the R-value. The only way to deal with a fiber insulation is to ventilate. But to ventilate means moving air which also decreases the R-value.

Air Penetration:

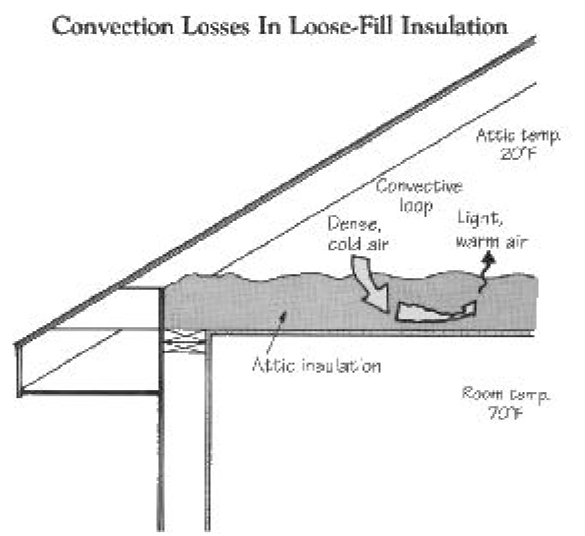
What is the R-value of a furnace filter? The filter medium for most furnace filters is fiberglass — the same spun fiberglass used as insulation. Fiberglass is used for an air filter because it has less impedance to the air flow, and it is cheap. In other words, the air flows through it very readily. It is ironic how we wrap our house in a furnace filter that will strain the bugs out of the wind as it blows through the house. There are tremendous air currents that blow through the walls of a typical home. As a demonstration, hold a lit candle near an electrical outlet on an outside wall when the wind is blowing.

The average home with all its doors and windows closed has a combination of air leaks equal to the size of an open door. Even if we do a perfect job of installing the fiber insulation in our house and bring the air infiltration very close to zero from one side of the wall to the other, we still do not stop the air from moving through the insulation itself vertically both in the ceiling and the walls.

The best known solid insulation is expanded polystyrene. Other solid insulations include cork, foam glass and polyisocyanate or polyisocyanurate board stock. The later two being variation of urethane foam. Each of these insulations are ideally suited for many uses. Foam glass has been used for years on hot and cold tanks, especially in places where vapor drive is a problem. Cork is of course a very old standby often used in freezer applications. EPS or expanded polystyrene is seemingly used everywhere from throw away drinking cups and food containers to perimeter foundation insulation, masonry insulations, etc. Urethane board stock is becoming the standard for roof insulation, especially for hot mopped roofs. It is also widely used for exterior sheathing on many of the new houses. The R-value of the urethane board stock is of course better than any of the other solid insulations. All of the solid insulations will perform far better than fiber insulations whenever there is wind or moisture involved.

Most of the solid insulations are placed as sheets or board stock. They suffer from one very common problem. They generally don't fit tight enough to prevent air infiltration. It matters not how thick these board stocks are, if the wind gets behind it. We see this often in masonry construction where board stock is used between a brick and a block wall. Unless the board stock is actually physically glued to the block wall air will infiltrate behind it. In this case it is virtually worthless as the air flows through the weep holes in the brick and around the insulation rendering it virtually useless. Great care must be exercised in placing the solid insulations. The brick ties need to be fitted at the joints and then sealed to prevent air flow behind the insulation.

The only commonly used solid insulation that absolutely protects itself from air infiltration is the spray-in-place poly-



At very cold temperatures, when the temperature difference across the attic insulation reaches a certain critical point, convection within the insulation can reduce R-value.

Nisson, J.D. Ned, JLC, "Attic Insulation Problems In Cold Climates" March 1992, pp. 42-43 urethane. When it is properly placed between two studs or against the concrete block wall or wherever, the bonding of the spray plus the expansion of the material in place will effect a total seal. This total seal is almost impossible to overestimate. In my opinion most of the heat loss in the walls of the home have to do with the seal rather than the insulation. For physical reasons, heat does not conduct horizontally nearly as well as it does vertically. Therefore, if there were no insulation in the walls of the homes, but an absolute airtight seal, there would not necessarily be a huge difference in the heat loss. This would not be the case if the insulation was missing from the ceiling. Air infiltration can most effectively be stopped with spray-in-place polyurethane. It is the only material (properly applied) that will fill in the corners, the cripples, the double studs, bottom plates, top plates, etc. The R-value of a material is of no interest or consequence if air can get past it.

Anecdotes:

During the 1970s my firm insulated a bunch of new homes in the Snake River Valley of Idaho with 1.25 inches of spray in place polyurethane foam in the walls. In 1970 the popular number for the R-value of one inch of urethane foam was 9.09 per inch. Using this value, we were putting an R of 1.25 x 9.09 = 11.36 in the walls. This was much less than the R = 16 claimed by the fiberglass insulators. Today, using the charts from an ASHRAE book, we would only be able to claim an R-value for the 1.25 inches of 7.5 to 9. Neither of these numbers make for a very big R-value. The reality is that the people for whom we insulated their homes invariably would thank us for the savings in their heat bills. They would tell us their heating bill was half of their neighbor's. They felt as if they saved the cost of the polyurethane in one, or at most two, years. This is anecdotal evidence, I know, but anecdotal evidence is also compelling and very real in our world. Most of these customers were savvy people. They would not have paid the extra to get the urethane insulation if it had not been better.

About mid 1975 I received a call from a division manager of one of the major fiberglass insulation manufacturers. The caller asked, "I understand that you are spraying polyurethane in the walls of homes?"

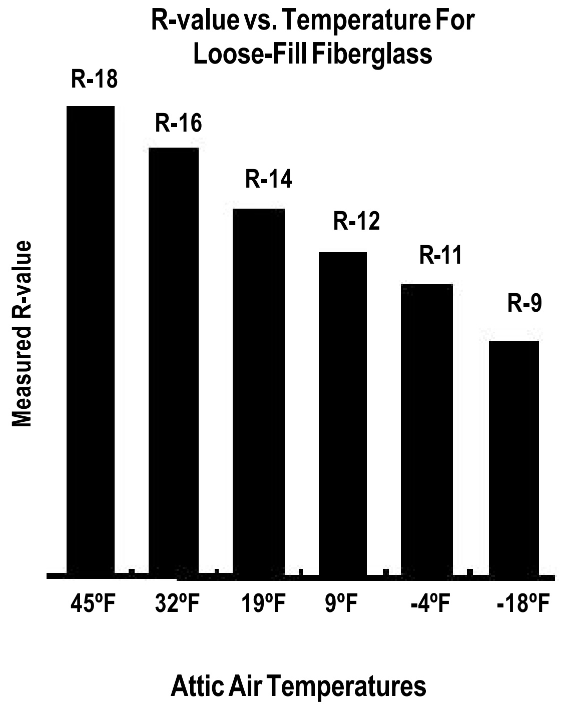
I told him that was true. He was calling because we were cutting into the fiberglass insulation sales in our area. He asked, "How can you do it?"

I knew what he meant. He wanted to know how I could look somebody in the eye and sell them a more expensive insulation than the cheap old fiberglass. I told him the way I did it is with a spray gun. Of course, that wasn't the answer he wanted. He wanted to know how I could not feel guilty. I told him of insulating one of two nearly identical houses built side by side. We insulated the walls with 1.25 inches of urethane. The other house was insulated with full thick fiberglass batts put in place by a reputable installer. Not only did we use only 1.25 inches of urethane as the total wall insulation, but we had the builder leave off the insulated sheathing. At the end of the first winter, the urethane insulated home had a heating bill half of their neighbor's. I know that is not terribly scientific, but it is very real. I am not sure he was convinced, but it should be noted that same company jumped into the urethane foam supply business the next year.

One and a quarter inch of polyurethane sprayed properly in the wall of a house will prevent more heat loss than all the fiber insulation that can be crammed in the walls — even up to an eight inch thickness. Not only does it provide better insulation, but it provides significant additional strength to the house.

One of my early clients was Brent. I had insulated several potato storages for Brent. He knew what spray-in-place

"There is a problem with loose-fill fiberglass attic insulation in cold climates. It appears that, as attic temperature drops below a certain point, air begins to circulate into and within the insulation, forming "convective loops" that increase heat loss and decrease the effective R-value. At very cold temperatures (-20°F), the R-value may decrease by up to 50%."



In full-scale attic tests at Oak Ridge national Laboratory, the R-value of 6 inches of cubed loose-fill attic insulation progressively fell as the attic air temperature dropped. At -18° F, the R-value measured only R-9. The problem seems to occur with any low-density, loose-fill fibrous insulation.

Nisson, J.D. Ned, JLC, "Attic Insulation Problems In Cold Climates" March 1992, pp. 42-43 urethane insulation could do. When he decided to build his new, very large, very fancy new home, he asked me to come insulate it. The builder pitched a fit. He "didn't need any of that spray-in-place urethane in his buildings. He made his buildings tight, and fiberglass was just as good."

Brent explained to the builder, "I know who is going to insulate the building. It is not as definite as to who is going to be the contractor. You can make up your mind. We are going to have the urethane insulation and you build the building, or we are going to have the urethane insulation, and I will have some one else build the building." It didn't take the contractor long to decide he wanted to use urethane insulation.

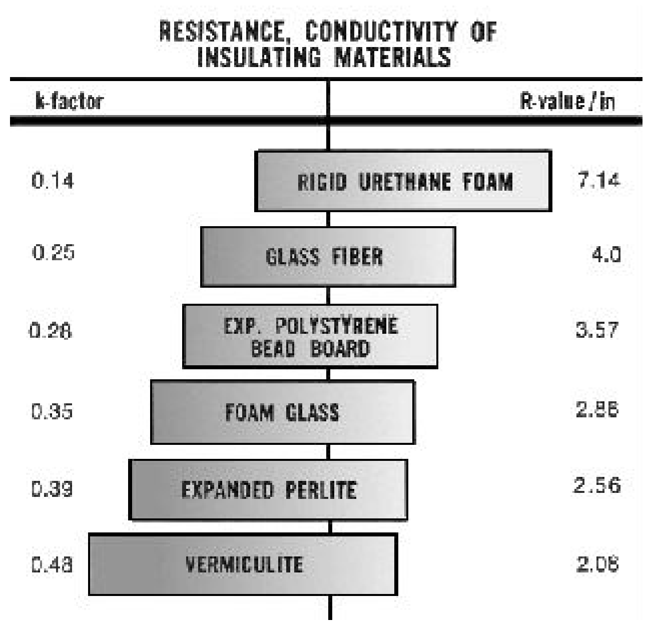
It was amazing to me how it worked out. We sprayed a lot of foam in Brent's house, and it cost him quite a bit of money because it was such a large home. Always after when I would meet him, he would tell me his heat bill was less than any of his rent houses or homes of anybody else he knew. And his home was two or three times larger. Also, the builder started having me insulate most of his new custom built houses. He told me he would explain to his clients the best insulation was the spray in place urethane. It would cost a little more, but it was by far the best. Most of the owners opted for the urethane. Never have I had a customer tell me that he did not save money by using the urethane spray-in-place insulation. You can spend all the time you want with R-values and "k" factors, and "prove" on paper there is no way the urethane can do the insulation job that the fiberglass will. In the real world, I can assure anyone there is no way fiber insulation can be as effective as spray-in-place urethane — not even close.

R-value tables are truly part of the "Fairy Tale." They show the solid and the fiber insulations side by side, implying they can be compared. The fact is, without taking installation conditions into account, comparisons are meaningless. Spray-in-place urethane foam provides its own vapor barrier, water barrier, and wind barrier. None of the other insulations are as effective without special care taken at installation. The fiber insulations must be protected from wind, water and water vapor. Again the tables need a second table to state installation conditions.

Other Anecdotes:

Meadow Gold Company was going to build a freezer in Idaho Falls, Idaho. Chet, the plant manager, was a good friend of the local Butler dealer. The local Butler dealer and I had become good friends. A Butler building does not lend itself very well to a freezer if you are going to insulate the freezer with expanded polystyrene. So the three of us got together and planned a freezer that would accommodate the needs of Meadow Gold yet be built of a Butler building and be properly insulated. This was in my first year of spraying polyurethane foam, and at that time I believed all the literature and knew what we were doing was going to be just right. It turned out even better. The then current R-value table showed one inch of urethane equal to 2.5 inches of expanded polystyrene. So, I suggested we spray the metal building with four inches of urethane to replace the 10 inches of expanded polystyrene normally used by Meadow Gold for freezers.

I sprayed under the slab with four inches, the walls with four inches, and the underside of the roof with five inches of urethane (the fifth inch was added as a safety margin). Chet, the plant manager, was pretty worried because he stuck his neck out going with this non-traditional insulation and the non-traditional building for Meadow Gold Company. Well, the building progressed on schedule, but the equipment to cool the building did not arrive on time. By summer only one of the two refrigeration compressors had arrived. Two



With the lowest k-factor and the highest R-value, urethane foam can provide more thermal resistance with less material than any other insulation.

compressors were needed (per the Meadow Gold engineers) to handle needs of the building based on using 10 inches of expanded polystyrene.

Chet considered one alternative to his predicament was to turn one of the older freezers that had been used as a cooler back into a freezer. Then maybe he could make a cooler out of the new building with just the one compressor. It was not a satisfactory arrangement, but it maybe could work. The other thing Chet kept telling us was that he would know as soon as he turned on the freezer equipment whether or not the building would work. When I pressed him, he said that normally it takes five days to bring a freezer down to 10 F below zero — needed for ice cream. When he turned on the new freezer, with only the one compressor, the temperature dropped to 18F degrees below zero by the second morning. They had their freezer. It ran the entire summer using only the single compressor.

Urethane Conserves Energy

Excellent thermal resistance is the primary performance benefit of urethane foam insulation, but it is not the only one. Urethane also has these advantages as a construction material:

a) Its closed cell structure makes urethane most effective initially and in the long run.
b) When protected by skins or other covering, urethane will not absorb water. Consequently the x-factor (thermal conductivity) is virtually constant.
c) Sprayed-on foam has the advantage of no seams or joints.
d) Urethane's thermal resistance means that only one thickness of material is need for most jobs.
e) It has a low moisture permeability (1-3 perms).

Where circumstances demand thinner walls or roofs, urethane — with its superior insulating capability — makes it possible to reduce the thickness of the insulation component with no loss of thermal resistance. Or the thermal resistance of an assembly can be increased without enlarging the size of the member. Urethane helps to offset the design restrictions imposed by the fact that most building materials are constant in thickness and weight.

"Urethane Foam as an Energy Conserver", How to Conserve Energy: in commercial, institutional and industrial construction, Mobay Chemical Corp. Pittsburgh, PA: 1975, p 3

A few weeks after start up of the freezer, I was visited by a Meadow Gold engineer from Chicago. He wanted to know exactly what we had done to insulate the freezer. One compressor should not be able to hold the temperature as it was doing. I explained to him exactly what we had done. He seemed satisfied and he left. A few weeks later he showed up again with his boss. We went to the plant and verified with an ice pick the thickness of the foam. It was indeed four inches in the walls and five inches in the ceiling. Here again they reiterated that the building should not be operating as it was. What they were telling me was that even though I had used one inch of urethane to replace 2.5 inches of expanded polystyrene, the building was still requiring only 50 percent of the normal compressor power for cooling. As you can imagine, the experience made me a lot more bold, and I used the information to sell more freezer insulation jobs.

One of our largest freezer insulation projects was a sixty thousand square foot freezer at Clearfield, Utah. I was able to talk the general contractor into letting us insulate with spray-in-place polyurethane foam the brand-new all-concrete freezer he was building. This building was the 12th in a chain of freezers. My friend Bob, the contractor, had taken it upon himself to make the switch from the ten inches of expanded polystyrene to four inches of urethane with a fifth inch on the roof. The building was built with tilt up concrete insulated on the interior side of the concrete with spray-in-place urethane. We then sprayed on a three-fourths of an inch thick layer of plaster as the thermal barrier. Over the pre-stressed concrete roof panels, we put five inches of spray in place urethane and then covered it with hot tar and rock. (This is an old CPR-specification).

I was on the job the last day. As we finished up the owner showed up. He had expected to see ten inches of expanded polystyrene, and here was four inches of urethane. I told him he would like the four inches of urethane as it would be even better than the expanded polystyrene, based on my previous experience. He told me he was sicker than a dog because he felt like there was no way that could be true. It was too late for him to do anything about it. If he could have, he would have changed the contract instantly, but he was stuck and felt stuck.

They had 12 other similar size freezers, except the others were insulated with expanded polystyrene. The normal way of operating them was to use three large compressor assemblies. Two of the compressors would be needed all summer to keep the building cold, and the third one would be a standby unit, in case one of the other two had problems.

About a year later, I received a phone call from one of the managers. He asked me if I had time to insulate another 60,000 square foot freezer in Clearfield, Utah. I assured him we had the time, the inclination, and the excitement to do it, but I thought the owner wanted nothing to do with urethane foam insulation. The manager explained to me that not only had the Clearfield freezer operated better than any other freezer in their line, it had operated for less than half the costs of any others. They were adding another 60,000 square feet without adding more compressors. The compressor power available to them because of the urethane insulation efficiency allowed them to do it. The building had run very nicely through the hot part of the summer with just one compressor. Now they would be able to run two buildings off of two compressors and still have a spare.

Again, this is anecdotal evidence, but let me assure you that you will get the same results if you do the same thing as we have. I have insulated too many buildings now that I know that this will happen in every case. Never can you use an R-value from a fiber insulation and compare it to the R-value of a foam insulation. Nor can you use the R-value of a foam insulation if it is in sheet form and compare it to the R-value of spray-in-place foam insulation. Spray-in-place polyurethane is an absolute minimum of three to ten times as effective as any other insulation available today.

During the late 1970s, the FTC went after the urethane foam suppliers for misleading advertising especially with regard to fire claims. A consent decree followed. It destroyed

Spray application of urethane foam is fast and efficient. Large wall areas can be covered in minutes. Urethane foam seals wall blocks and around furring to provide seamless, uniform insulated surface.

a tremendous amount of confidence in the use of urethane. Up to that point, Commonwealth Edison would give Gold Medallion approval for homes insulated with 1.25 inches of spray-in-place urethane in the side walls of masonry constructed homes. True, that was anecdotal evidence, but also true, it worked. Much work was done in the early 1970s using a 1.25 inches urethane as a replacement for wall insulation in a home. Not only did it replace the wall insulation, it also replaced the exterior sheathing. Buildings are stronger and better insulated when sprayed with the 1.25 inches of urethane.

Understanding the two purposes of insulation gives a standard to measure the insulations:

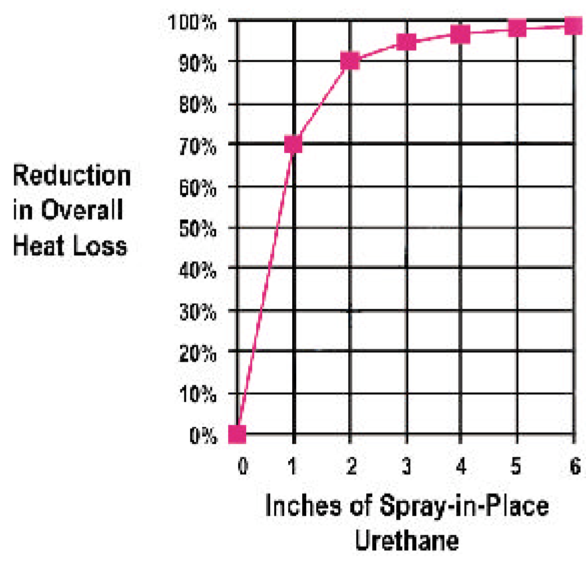
1) Heat loss

There is a little understood part about insulation that needs to be covered. There is a substantial difference between insulation for temperature control and insulation for heat loss control. For instance, the graph shows the heat loss control of the spray-in-place urethane foam insulation. Any insulation will have a similar graph but with thicker amounts of insulation. This graph points out that more insulation is not necessarily cost effective. There is a point where more insulation is pointless from a total heat loss perspective.

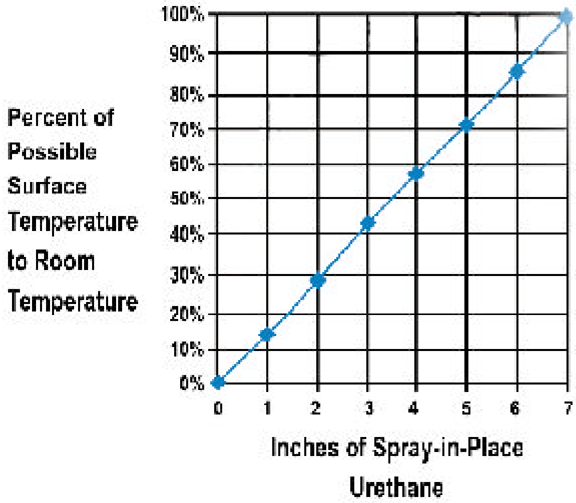
The graph shows that 70% of heat loss from conductance is stopped by a 1 inch thickness of spray-in-place urethane foam. (remember we are going to stop nearly 100% of the heat loss from air infiltration with the first one-fourth of an inch of urethane foam). The second inch of spray-in-place urethane stops about 90% of the heat loss and the third inch 95% and so forth.

Thermal Diffusivity — Heat Sinks:

It should be noted here that when the urethane is used on the exterior of a heat sink, such as concrete, the actual effective R-value is approximately doubled. This is why with the Monolithic Dome, we are able to calculate effective R-values in excess of 60. A heat sink is any substance capable of storing large amounts of heat. Most commonly we think of concrete, brick, water, adobe and earth as heat sink materials used in building. The property of a heat sink to act as an insulation is called thermal diffusivity. The simple explanation for the way it works is: As the temperature of the atmosphere cycles from cold to hot to cold to hot the heat sink absorbs or gives up heat. But because the heat sink can absorb so much heat it never catches up with the full range of the cycle. Therefore the temperature of the heat sink tends to average. Large heat sinks will average over many days, weeks or even months. An example is the adobe hacienda with its 2 to 6 foot thick walls. By the time



This graph illustrates the reduction in heat loss from a building when it is insulated with various thicknesses of spray-in-place urethane foam. Note: the insulation benefit tops off very quickly above three inches. The graph is not exact, but it shows in general what happens as additional insulation is added to the surface temperature. In other words, by super-insulating, the surface temperature of the inside of the exterior walls comes very close to the room temperature. This prevents the condensation, which prevents the growth of mold.



Factors such as ambient air temperature, wind, size of structure, and most importantly, the heat sink available to the structure, may influence the actual heat loss. Other types of insulation will have similar graphs, they just will not be quite as dramatic.

the adobe walls begin to absorb the daytime heat it is night time and the same heat then escapes into the cooler night. Therefore the temperature would average. Because the mass of the adobe is so large the temperature averages over periods of months. Adobe acts as an insulation even though adobe has a minimal "R" value.

You can see from the graph that urethane thicknesses beyond four or five inches is practically immaterial. We use three inches for most of our construction. Two inches will do a very superior job. We have insulated many metal buildings with one inch of urethane and the drop in heat loss is absolutely dramatic. Obviously the first quarter inch takes care of the wind blowing through the cracks (It usually takes an inch to be sure the cracks are all filled). The balance of the inch adds the thermal protection.

2) Surface temperatures control:

Surface temperature control is the second reason for insulation. In many cases it is the most important reason for the insulation. I noticed this phenomena first while insulating potato storages. We had various customers ask us to insulate the buildings anywhere from two to five inches of urethane. The building insulated with two inches would hold the temperatures of the potatoes properly, just as well as the building insulated with five inches. The difference came in the condensation. Potato storages are kept up at very high humidity levels. The buildings with the two inches of urethane would have far more condensation than those with the five inches.

An engineer from the Upjohn company explained this to me. He drew for me a graph as shown here. It shows that thicker insulation is absolutely necessary to maintain higher interior surface temperatures. One and a half inches of urethane on the walls and ceiling of a potato storage would control the heat loss from the building, but it took a minimum of three inches of urethane to control the interior surface temperature. Four inches was even better. With five inches did difference is practically negligible. The only place where we have felt the need for five inches of urethane was insulating the roof or ceiling of a sub-zero freezer.

Underground housing — surface temperature control vs. heat loss control

Most of the underground housing is in trouble from mold and mildew growth. The cause is not enough insulation to control interior surface temperatures. Rarely is there a problem with total heat loss. Water vapor condenses on the surface allowing mold to grow. Mold makes people sick. The only solution is lots of insulation for temperature control and ignore total heat loss as it will not be a factor.

My experience is that R-value tables can be used as indicators. They need modifications to make them equal to real world conditions. There needs to be allowances made. They must show equivalents. These equivalents will be more like one inch of spray-in-place urethane equal to four inches of fiberglass in a normal installation. Footnotes to the table will need to define degradation of insulations in real world conditions. Only then will the "R-value" Fairy Tale become a real world success story. m

MONOLITHIC
DOME INSTITUTE

Purchasing a School or Other Public Building

By David B. South

Word Picture

First, identify your wish list. Describe your needs and wants. We refer to this as a *word picture*. The more detailed the descriptions, the easier to design and price. Include in your word picture what is available: assets, land constraints, building constraints and time constraints. This word picture can be furnished by the owner and staff or by hiring a professional to create it. Usually, a combination of both is the best.

Design/Bid/Build

Traditionally, at this point, architects are interviewed. Each architect presents past projects to the owner in an effort to win the project or the owner's approval for the project. This is often referred to as a Beauty Pageant. The architect selected then works with the owner to produce the program. At this point most of the control of the project passes to the architect. Obviously, the architect can be dismissed, but this is costly and rare. The architect now "leads the charge" to get the building in place. He designs it, puts it out to bid, selects the lowest bidder (not very much choice here), inspects it, then follows through to completion. The architect is paid a percentage of the total cost. Therefore, cost savings are not to his advantage. Traditionally most public buildings are purchased this way.

Design/Construction Management/Build

Over the past several years, Monolithic has been working on a variation of the above method called *design/construction management/build*. With this method, the design phase is the same, but a construction manager (CM) is hired by the owner to do the actual construction. The CM and the owner collect and select many individual bids for various parts of the building such as the plumbing, electrical, seating, etc. The owner retains more control and is very involved in all decisions as the building progresses. Design/Construction Management/Build is considered by many to be much more effective than Design/Bid/Build.

Design/Build

The best way for project delivery is called *design/build*. Traditionalists don't like it and CMs fight it — mostly because they lose some control. Nevertheless, it is being used more and more. To begin the process, the school board hires an architect or engineer to issue a call for design/build bids for the project. Any contractor can then work with his own architect to provide the structure. The board architect or engineer can help the school board decide on the most advantageous bid and monitor the construction for compliance. This procedure is almost identical to that of purchasing a school bus. Many federal jobs and private projects are now being done using the design/build method. In fact, studies show this to be the most effective delivery system. School boards are authorized to use design/build and should seek to use this superior system of procurement. The feasibility study is especially effective with the design/build option.

Feasibility Study

The *feasibility study* is a variation which fits each of these systems. For a fixed fee, a design professional takes the word picture, develops a feasibility study and creates a concept design. Next, a budget is arrived at using the selected design. Thus, for a modest fee the owner can have a very good idea of costs and solutions before continuing on with any of the above delivery systems.

Call us today or visit www.monolithic.com to learn more. We can arrange for a feasibility study to be done and help you get what you want at a price close to the determined budget.

MONOLITHIC®

School Pricing

How much does a car cost? It depends on the make and model and age and condition, etc. Likewise, school costs also depend on -- where, when, purpose, location, and more. But a few ideas are in order:

1. Generally a Monolithic Dome School will cost less than a conventional school. It will cost a lot less than a conventional school if the conventional school is constructed to meet the Type II or Type II FR designation (Fire safe code designations).

2. The lifetime of the Monolithic School is measured in centuries. Remodeling may be needed from time to time to meet changing conditions over decades of use, but new structures will not be needed.

3. The dramatic difference in energy needs between the Monolithic Schools and conventional is where the big savings are. Less equipment is needed for heating and cooling. Less electrical is needed for the less HVAC equipment. Less equipment needs less maintenance and less replacement when it wears out. If the savings were accumulated in a bond account --- it would be reasonable to have the accumulated saving equal the total cost of the facility in less than 20 years. (The superintendent of Pattonsburg School -- Gene Walker said 11 years for their new school).

4. Inflation of construction (see graph Winter 2000 Roundup, page 46) will distort any numbers given here --- So will other factors such as: It is more costly in the Northeast and California, prevailing wage states, and experience of builders and designers.

In general the schools have been finishing between $110 and $125 per square foot. The most Monolithic Dome schools are located in Arizona. There, conventional schools priced out about 18% more in initial cost and obviously they did not have the energy savings of the Monolithic Dome Schools.

How to Proceed? Our recommendation is to commission a feasibility study. The feasibility study is completed by one of the designers familiar with the attributes of the Monolithic Dome. A few thousand spent on the front end of the project pays very large dividends in useful information. You may still use your local architect for the final design.

The great part about a feasibility study is the "preliminary program" established. A solution is proposed and a rough budget is created. Then the decision can be made to proceed or make major changes. The School is not obligated beyond the cost of the feasibility study.

Please let us know what we can do to help. We would like to start with coordinating a feasibility study.

June 19, 2007

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MONOLITHIC®

Commercial Feasibility Study

Schools, Churches, Gymnasiums, Office Buildings, Storages, and more

A Feasibility Study is a preliminary study for a project comparing the Monolithic Dome Process to other building systems. The study defines for the owner the design and intent of the project and provides an estimated budget from the best available information. Monolithic Dome Institute offers to produce a feasibility study for assistance to MDI clients before architectural services are engaged. This study will not provide plans for construction purposes.

MDI will engage qualified design professionals to study the owners program. A budget will be established utilizing the information from the design professionals working with the Monolithic Construction Management personnel.

The Client will provide:

- A program describing rooms, space uses and equipment
- A site plan, survey, and/or plot description of the owners property

MDI will provide:

- A preliminary site schematic developed from information furnished by owner.
- A floor plan to scale showing all described space uses.
- An exterior sketch of proposed front building elevation.
- A factual report and estimate of cost for construction using a square foot method based on recent projects of similar type near the same location if possible.

Optional Services Available at extra cost:

• Space planning consultation	$300.00
• Interior Volume Analysis Studies	Call for Quote
• Dome openings and exterior attachment information	$200.00
• Code compliance and testing information	Call for Quote
• Acoustical Design Studies and Sound System Consultation	$350.00
• Bulk storage layout, sizing and placement of inbound and outbound conveyors	$200.00
• Full color rendering	Call for Quote

With the study report and the budget, the owner can evaluate and decide to proceed with information to be given to a local architect, banker or building official. There is no obligation beyond the study itself. The basic fee is starts at $7,500.00, plus travel expenses, if needed (very large studies may require a larger fee.) Fifty per cent (50%) is due with the order for the study. The balance is due upon completion.

Accepted by: Date ________________

____________________________ ____________________________

Print Name and Title Signature

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