# SPF Crew Seals Monolithic

*By Jack Innis*

When spray polyurethane foam (SPF) contractor John Kuchta, Jr. received word he'd won the bid to insulate a new-construction home in Hayes, Virginia, he knew his crew would have to face a few new challenges.

But hey! Kuchta's crew has a track record of spraying foam in a wide variety of applications. Combat Coatings, LLC, insulates metal warehouses, brick office buildings, wood-frame medical facilities, and has even retrofitted homes in the past. What could be so danged difficult about spraying three inches of NCFI Polyurethane's (NCFI) two-pound, closed-cell foam to help create a monolithic dome home?

Kuchta was about to find out.

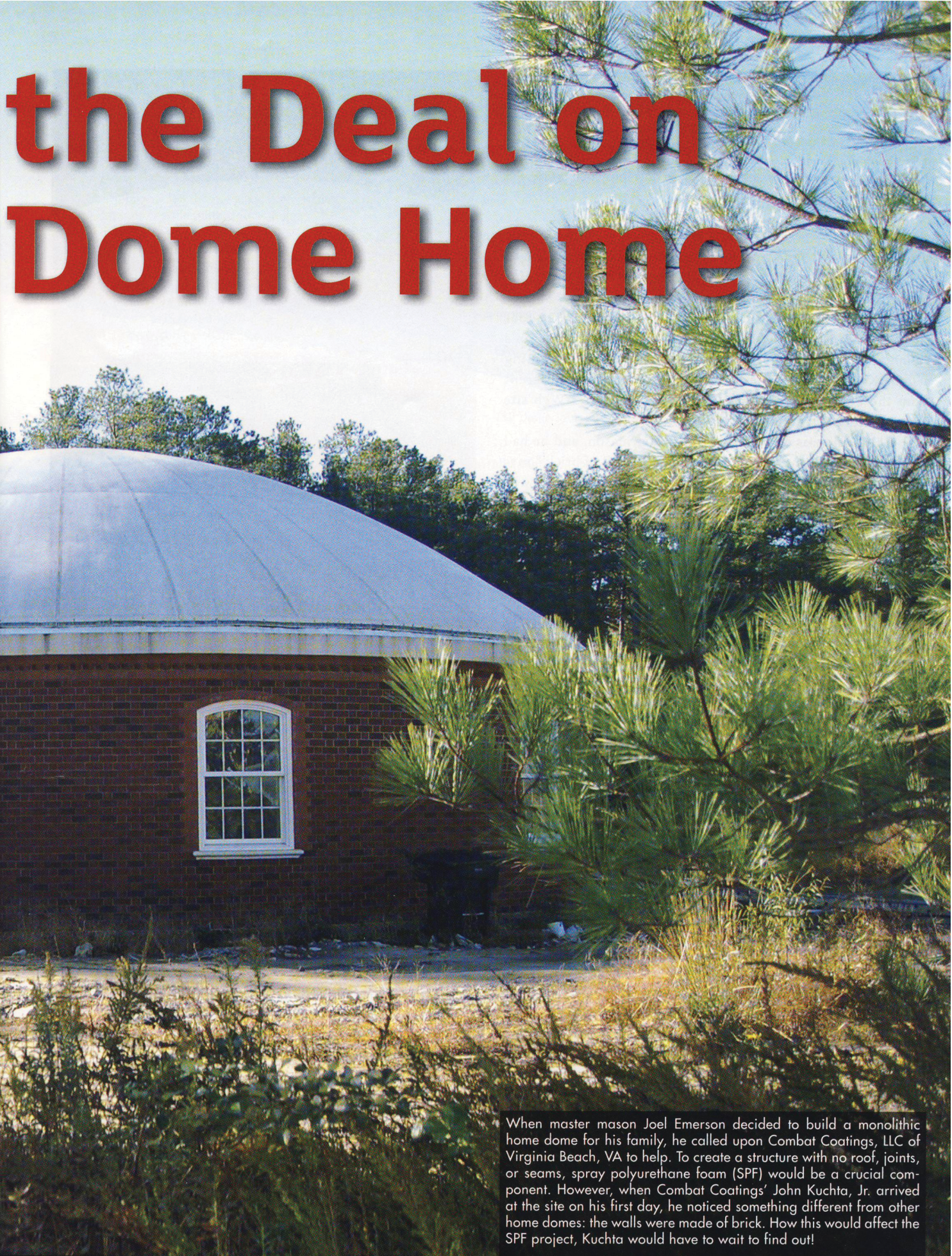
## No Box to Think Outside Of

What do you get when you think so far outside the box that the box disappears? A monolithic dome home! These shell-like structures — with no roofs, no joints, and no seams — are among the most energy-efficient in the world. But they can't be built without SPF!

According to the Monolithic Dome Institute, the construction technique was perfected in the mid-1970s when founder David B. South sought to create a highly insulated potato storage facility in Idaho. Today, monolithic dome homes, schools, gymnasiums, bulk storage facilities, churches, offices, and other structures are found in 45 states and a handful of foreign countries.

Monolithic dome structures are created without support framing. The process begins when tradesmen attach a giant dome-shaped tarp — called an Airform — to a circular concrete foundation. Heavy duty fans inflate the dome to a flattened hemispherical shape. A one-and-a-half-inch layer of SPF is sprayed onto the inside of the dome. Workers press specialized hangers used for rebar into the foam. Then, a second one-and-a-half-inch layer of SPF is applied to anchor the hangers. Tradesmen affix rebar onto the hangers. Spray concrete professionals broadcast four inches of swimming

# the Deal on Dome Home



When master mason Joel Emerson decided to build a monolithic home dome for his family, he called upon Combat Coatings, LLC of Virginia Beach, VA to help. To create a structure with no roof, joints, or seams, spray polyurethane foam (SPF) would be a crucial component. However, when Combat Coatings' John Kuchta, Jr. arrived at the site on his first day, he noticed something different from other home domes: the walls were made of brick. How this would affect the SPF project, Kuchta would have to wait to find out!

To create the dome shape used for the top of the home, Kuchta needed to create constant support from underneath the Airform tarp. He used high-volume fans to supply the low air pressure, and contained the air by using a two-door air lock. Unfortunately, these doors, the only way in and out of the structure, couldn't accommodate Combat Coatings' spray foam equipment. Their solution: create a small portal and seal the hole with a gasket. With the heated hose and spray gun inside, the crew was ready to get to work.

pool-type spray concrete to create an extremely rigid monolithic structure. When the concrete dries, the fans can be turned off. The Airform, which remains in place on the outside of the shell, may receive an exterior coating.

Kuchta had all this in mind when he pulled his 28-foot Gusmer-brand gooseneck SPF rig alongside Joel Emerson's 2,200-square-foot home under construction. But something caught Kuchta's eye: Emerson's foundation looked different from the one seen on Monolithic Dome Institute's Web site (www.monolithic.com).

"The home was being built by a master mason, and he had the idea of creating a 10-foot-high perimeter wall of brick," says Kuchta. "It's a work of art from the outside. I don't know how he did it, since attaching the Airform to ground-level concrete can be a challenge. But Joel had somehow attached the Airform to the top course of brick and had it fully inflated when we got there. My first question to him was, 'How the heck do we get our spray foam equipment inside?' "

## No Foam, No Dome!

Relatively low air pressure supplied by high-volume fans such as those used to circulate air inside grain elevators supports a monolithic dome throughout the construction process until the final layer of spray-applied concrete hardens. But until that concrete sets up, the only way to get inside an inflated dome is through a two-door air lock.

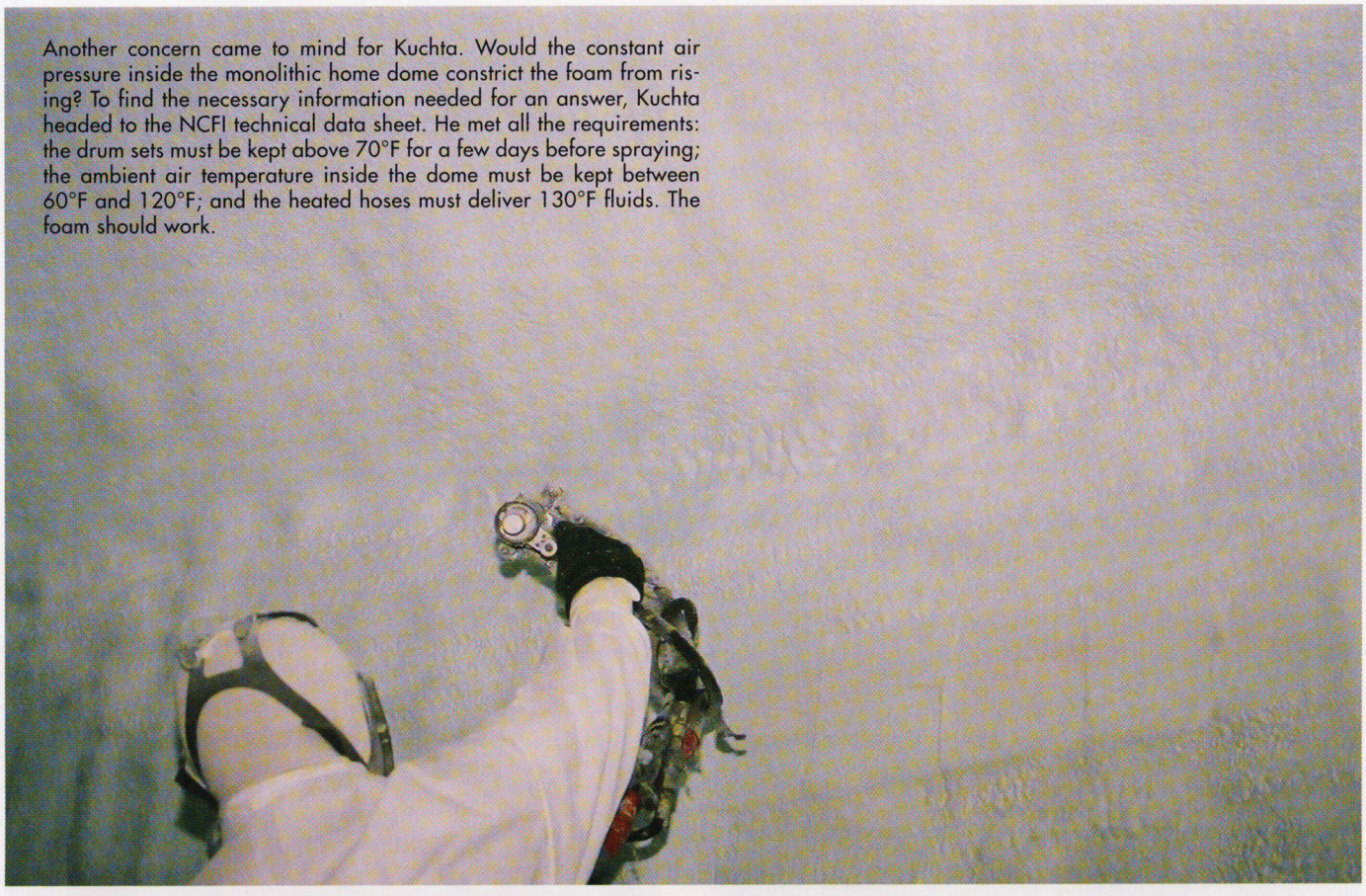
The problem was that Combat Coatings' spray equipment couldn't fit through the air lock. Kuchta also observed that he couldn't simply snake the heated hoses through the air lock. Leaving the doors ajar before the final concrete coat sets up invites a complete and catastrophic collapse of Airform, SPF, rebar, and concrete.

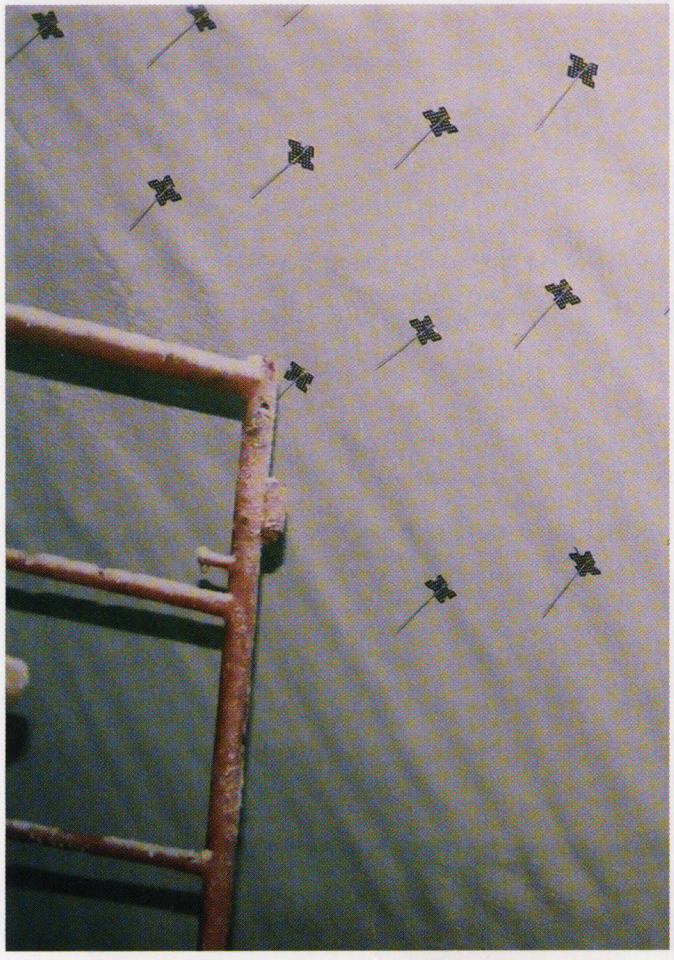
For a while, it looked as though this oversight might send the SPF team packing. But Kuchta and Emerson huddled up and came up with a plan.

"Access to the house was easy," says Kuchta. "We could back the trailer right up to the air lock. But the hoses presented a problem. Joel finally had to chisel out a brick and build a small portal. We passed a section of heated hose through, and Joel sealed

Once inside, the Combat Coatings crew spray-applied a 3" layer of NCFI 2 lb closed-cell foam over the brick support wall. They covered the brick in two layers with no problem. When they sprayed higher, though, they noticed a pressure problem. The air pressure inside the dome was forcing the Airform to balloon upwards. When the top bricks started to crack, Emerson came in to repair the structure before too much damage could be done. With the bricks set again, the SPF crew continued to spray the dome with 1.5" of the same foam.

Another concern came to mind for Kuchta. Would the constant air pressure inside the monolithic home dome constrict the foam from rising? To find the necessary information needed for an answer, Kuchta headed to the NCFI technical data sheet. He met all the requirements: the drum sets must be kept above 70°F for a few days before spraying; the ambient air temperature inside the dome must be kept between 60°F and 120°F; and the heated hoses must deliver 130°F fluids. The foam should work.





the hole with a gasket he'd made. We connected other hoses to that and strung them up to the Gusmer 1600 series air-driven proportioning pump in the trailer. We brought our spray guns (Gusmer GAP Pro with #01 mixing chamber) in through the air lock, hooked up, and were ready to go."

## Hate to Burst Your Bubble

With 130°F heated hoses running through the portal, Combat Coatings' crew fired up their equipment. First task at hand was to spray, in two passes, a three-inch layer of NCFI two-pound closed-cell foam to cover the brick support wall. But a worrisome thought crossed Kuchta's mind. Would the air pressure inside the dome somehow affect the foam's ability to rise?

Kuchta mentally checked off NCFI's technical data sheet for application information: Drum sets kept above 70°F for a few days before spraying? Check. Ambient air temperature inside the dome between 60°F and 120°F? Check. Heated hoses tuned to deliver fluids at 130°F? Check!

Nowhere in the tech sheet did it mention ambient air pressure, nor was there a ready way to determine air pressure inside the dome.

The next step for the SPF crew was to help insert 2,500 metal hangers into the foam. These hangers were used to hold rebar into place to give strength to the dome. Emerson used a mason's laser level to place the hangers in a pattern determined by the size and shape of the dome. On top of that, a layer of spray concrete would be installed to the rebar to create one solid structure. To give them additional support from being pulled off the wall, Combat Coatings planned to spray the 2"-square flat sections on the hangers with SPF.

Once all of the hangers were in place, Combat Coatings needed to spray an additional 1.5" layer of foam to sandwich the metal hooks into the wall. To reach the sides and top of the dome, the SPF crew worked on low scaffolding supplied by Emerson. They followed safe practices while working off and on the ground. This included wearing 3M organic filter masks and full-hooded Tyvek suits while spraying. They also used Nextel cell phones to maintain communication between the workers outside and inside the dome.

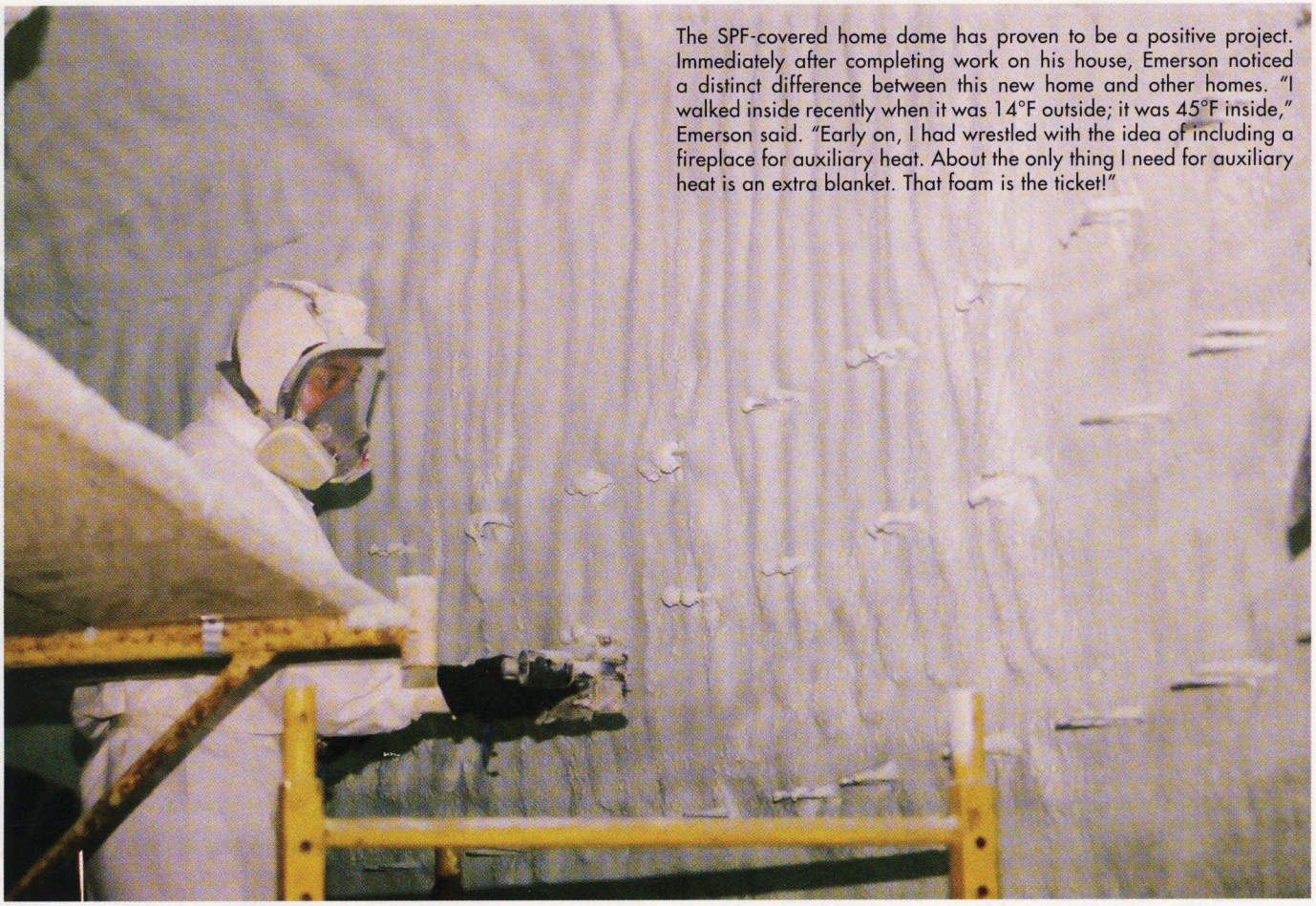
"They don't rely on pressure gauges," explains Emerson. "Before you pressurize, you take an eighth of an inch clear plastic hose and connect it to the bottom of a small reservoir inside the dome. You run the other end of the hose through the portal and secure it outside to a stake in the ground. Since water always seeks its own level, the waterline on the exterior is at the exact same grade as the water level inside. When you pressurize, you want the outside water level two inches higher than the inside."

Absent any hard data to share with NCFI's tech support team, Kuchta grabbed the GAP Pro gun and made the first one-and-a-half-inch pass along the bottom of the brick wall. Thankfully, the air pressure didn't interfere.

But as he sprayed his way toward the top of the wall, a more serious problem came to light.

## Up, Up, and Away!

For centuries, masonry walls have shown their ability to withstand enormous compressive loads. But brick walls do not offer quite the same strength when being pulled apart. In this case, air pressure inside the dome created so much upward force that the Airform wanted to sail off like a hot air balloon.



The SPF-covered home dome has proven to be a positive project. Immediately after completing work on his house, Emerson noticed a distinct difference between this new home and other homes. "I walked inside recently when it was 14°F outside; it was 45°F inside," Emerson said. "Early on, I had wrestled with the idea of including a fireplace for auxiliary heat. About the only thing I need for auxiliary heat is an extra blanket. That foam is the ticket!"

"Unfortunately, we had to put so much pressure to hold up the Airform that it began cracking bricks at the top course," says Emerson, who worked late into the night for a few days to repair the cracks. "Anytime you're dealing with a prototype, you're dealing with all sorts of problems."

## Working Under Pressure

Using scaffolding provided by Emerson, the Combat Coatings crew sprayed the dome from the bottom up.

"We were able to go completely around the dome, spraying directly onto the plastic dome of the roof," said Kuchta. "The Airform was very sturdy — sort of like spraying against plywood."

After the entire dome interior was covered with one-and-a-half inches of SPF, Kuchta and his crew helped insert approximately 2,500 metal hangers upon which rebar could be hung. The barbed hangers have two-inch-square flat sections that ultimately became sandwiched between SPF layers for additional resistance against being pulled out of the foam. Emerson brought in a mason's laser level to ensure the hangers perfectly aligned with a predetermined pattern dictated by the dome's size and shape.

With all 2,500 hangers in place, the Combat Coatings crew sprayed the second and final one-and-a-half-inch layer of SPF.

The rebar hanging and spray concrete installation went off without a hitch. After the concrete dried, the fans were turned off and the dome became freestanding.

## Cool Dome! Hot Concept!

Although much finish work remained to be done, Emerson immediately began to appreciate the energy efficiency of the dome he'd just created.

Lacking joints and seams, the monolithic dome has fewer leak points than do traditional framed structures.

Spherical shapes also cover more surface area with less material than do rectangular prisms or cubes. By doing so, domes lose less heat in winter and gain less heat in summer through conduction. Finally, the foam-and-concrete sandwich shell is rated high in thermal efficiency. According to the California Energy Commission's "Passive Solar Handbook," concrete-and-SPF-layered walls are among the best at maintaining interior heat because the foam blocks heat transfer, and the concrete acts as a thermal mass, dampening out interior temperature fluctuations.

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For Kuchta and his Combat Coatings crew, the job had a few nervous moments, but for the most part, it went off smoothly. Kuchta is certain Emerson will enjoy great energy savings for years to come.

"I'm completely confident in this application," Kuchta says. "You can't build a monolithic dome home without SPF, and NCFI's two-pound, closed-cell foam really helped seal the deal." **SF**