

About 21,000 square feet of new copper covers the 306-foot-tall Kansas State Capitol in Topeka.

RED ROOF makeover

When copper shows its age, crews use new metal to restore state capitol domes

BY NICK WRIGHT

With the midterm elections fading from Page 1, the electorate can turn its attention to the buildings where some of the new legislators and their staffs will work: state capitols. The majority of state capitols are more than a century old, constructed from materials like heavy masonry that will endure indefinitely. But the most visible and recognizable feature of most state capitols is that which protrudes upward—typically a cupola or dome made from stone or metal.

According to the National Conference of State Legislatures, nine state capitols currently have copper domes, which, if viewed in a time-lapse video, would show the transformation from penny-bronze to brown to green. In the past year, the capitols of Maine and Kansas had their copper domes restored with new material as the old patinated copper gradually deteriorated. Copper is ideal for its resistance to corrosion, but designed as a roofing system made from bent sheet, exposed to the lows and highs of winter and summer, respectively, it doesn't last forever. Crews on each statehouse discovered up close the effects



Earlier this year, crews replaced the Maine State House dome's copper with 20-ounce sheet.

of 100-plus years on the copper domes.

Without the restoration work, moisture could work its way into the building, causing damage unseen. With new copper, the restorations represent not just a necessary modernization but a change in the way residents perceive their statehouse.

Pine Tree State

Located in Augusta, the Maine State House dome saw the replacement of all 7,000 square feet of copper. According to the Maine State House multiyear maintenance plan in 2013, the dome is over 100 years old and has surpassed its 75-year life expectancy. The State House was built in 1832 and topped out at 185 feet tall after the dome was added during remodeling in 1910. Since 2002, a regular maintenance program has fixed seams, replaced rivets and minor paneling. But continuous weathering steadily wore down the copper's thickness to the point where dime-size holes were appearing in open panel areas. This left the dome vulnerable to leaks and compromised the overall integrity of the copper beyond what maintenance could remedy.

The Heritage Co., a Waterboro, Maine, coppersmithing firm, installed the new cladding, which was supplied by Rome, New York-based producer Revere Copper. The material was 20-ounce sheet in 3-foot by 8-foot sections. All the panels were custom cut and bent to match the prevailing dome's shape either in Her-

itage's shop or on site. The copper was fastened with hidden clips to the underlying substrate, says Grant Pennoyer, executive director of the Legislative Council, the group charged with maintaining the capitol and its grounds.

"The existing substrate is a concrete shell with built-up wood to create the raised coifers," Pennoyer says.

Overall, the State House restoration cost Maine about \$1.45 million, of which the copper roofing portion cost \$500,000. The project presented challenges not only due to the building's age, but the logistics of scaffolding the dome and hoisting materials so far off the ground.

"From a copper standpoint, the most difficult part was replicating the original intent of the installation while making sure we accounted and incorporated new techniques," Pennoyer says. To mitigate failures from the original installation from happening again, crews added expansion joints at strategic locations throughout the dome's structure and installed a rosin slip sheet under the copper. As part of the renovation completed in late November 2014, crews also regilded an 18-foot-tall statue called Lady of Wisdom.

Sunflower State

The Kansas Statehouse in Topeka was built in three phases over the course of 37 years, the first of which began after the Civil War in 1866. The rotunda and dome were built with the completion of the third phase in 1903. In addition to the 71-foot diameter dome, the entire Kansas Statehouse roof system is made from copper.

The dome was not part of the original comprehensive 10-year restoration plan for the Kansas Statehouse's masonry exterior, says Vance Kelley, principal at Treanor Architects, the firm that completed the restoration in December 2013.

"They had some previous repairs done on the dome, and felt it was in a sufficient condition to exclude it from the scope of work on our project," he says. But, as crews began working on the copper roofing, Treanor determined the repair approach adopted by the state early in the planning couldn't address the rate of deterioration of the roofing system.

"In 2010, when we opened some ma-



Ornametals fabricated specialty elements for the Kansas Statehouse at its manufacturing plant in Alabama.

STATE CAPITOLS WITH COPPER DOMES

Several states, such as Massachusetts, once had a wooden dome sheathed in copper, or have copper roofing elsewhere on the capitols (like the cupola). These states currently have copper domes.

- **California:** Copper clad dome topped with gold domed cupola adorned with a gold-plated copper ball
- **Indiana:** Copper dome topped with a copper domed cupola adorned with a flagstaff
- **Kansas:** Copper dome topped with a copper domed cupola adorned by a bronze statue of the Kansa warrior, Ad Astra (which was placed on top of the dome in 2002)
- **Maine:** Copper dome topped by a lantern cupola adorned with a gilded copper statue of a female figure Lady of Wisdom holding a lighted ball aloft
- **Montana:** Copper dome topped with a statue of Lady Liberty
- **North Carolina:** Copper dome with anthemion crown
- **South Carolina:** Copper dome topped with a copper domed cupola and a flagstaff
- **South Dakota:** Copper dome topped with a copper domed cupola
- **Utah:** Copper clad plaster and terra cotta dome topped with a copper clad domed cupola, and an illuminated globe

Source: National Conference of State Legislatures; state websites

sonry eaves where the stone meets the copper roof systems, we saw areas where the building hadn't been opened since it had been built originally. We could see a lot of the hidden deterioration underneath," Kelley says.

The replacement sheet copper ranged

in thickness from 20- to 32-ounce depending on the element and its function. About 65,000 square feet of copper covers the roof, 21,000 square feet of which covers the dome. The construction manager, Kansas City, Missouri-based JE Dunn Construction hired Baker Roofing Co., Raleigh, North Carolina, and MG McGrath Inc., Maplewood, Minnesota, as sheet metal fabricators. Ornametals Mfg. LLC in Cullman, Alabama, custom made ornamental trim for the cupola.

According to Carl Holden, marketing manager at Ornametals, the company fabricated copper elements including radius hips, 0.1-millimeter oriel windows, radius bullnoses, 0.8-millimeter rib caps, all radius moldings and stamped radius parts, and the complete cupola lantern including its pommel band and sphere. Aurubis and KME Group, both Europe-based copper makers, supplied Ornametals' material.

Standing seam 20-ounce copper made up the radius components at the base and top of the dome, according to Kelley. Roofing crews replicated the original horizontal seamed panels, called Bermuda paneling, with 20-ounce copper.

"We had to create templates for each of those to account for the compound curvature differences as it moved from the bottom of the dome to the top in each of those pie-shaped spaces," he says.

All told, the dome had over 230 linear feet of built-in monumental gutter fabricated from 32-ounce copper installed, more than 750 linear feet of 24-ounce copper rib molding, and 32-ounce copper was used for the ornamental surrounds at the 16 5-foot-diameter windows around



the dome. An interior copper dome sits below the exterior dome so when tourists look up, it's a second glass-and-copper dome they see.

The 306-foot-tall statehouse is topped by Ad Astra's bow, a sculpture of a Kansa warrior cast from silicon bronze. The entire renovation cost about \$323 million of which the copper roof and dome cost \$21.7 million. At one point, the Kansas legislature explored the idea of chemically inducing the new copper's green patina because for decades dark green was the dominant color. But it decided ultimately to allow the copper to age naturally.

Remaining copper

In both Kansas and Maine, all the removed copper was recycled in some form.

Ornametals was awarded the 2014 Copper in Architecture Award for its trim and window work on the Kansas Statehouse.

In both states, some of the copper was set aside for artists to create public art, or sold to local jewelers to create copper jewelry for sale in the statehouse gift shops. In Maine, any money made from selling the old copper is helping to offset the dome project costs.

Other state capitols have undergone renovations to copper roofing, including Nebraska in 2010, but that project didn't include any dome work (Nebraska's dome is gold-tiled). The new copper roof and dome in Kansas is expected to take longer to patina, and ultimately last longer than the previous material in part because certain pollutants, like coal for heating, aren't used anymore in the building, says Kelley.

"I'm not sure I'll see the dome green in my lifetime," he says, "because it could take 30 years."

But in Maine, changes in the surface are apparent. Pennoyer says the dome began to lose its initial shiny appearance last month already. ■

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