ALL HANDS ON ROOF DECK

WAGNER ROOFING RESTORES FIVE ROOF SYSTEMS ON THE U.S. NAVAL ACADEMY'S MAHAN HALL

BY CHRYSTINE ELLE HANUS

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Photos courtesy of Wagner Roofing Co., Hyattsville, Md.

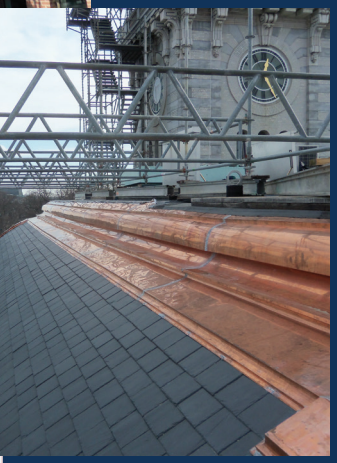
Top to bottom: A stair tower was installed for access and egress; new decorative copper flashing at the intersection of the slate mansard and flat-seam copper roofs

The U.S. Naval Academy in Annapolis, Md., prepares young men and women to become professional officers in the Navy and Marine Corps. Serving as the undergraduate college for the U.S. naval service, students attend the academy for four years, graduating with a bachelor's of science degree, and then commission as ensigns in the Navy or second lieutenants in the Marine Corps, serving at least five years.

Designated a National Historic Landmark in 1961, the U.S. Naval Academy commemorates bravery and heroism with monuments located throughout its campus. Buildings and walkways are named after Naval Academy graduates who have contributed to naval history and their nation.

At the core of the campus is the academic complex of Mahan, Maury and Sampson halls. Constructed in 1907, Mahan Hall's 104-year-old copper, polymer-modified bitumen and slate roof systems were overdue for replacement. Wagner Roofing Co., Hyattsville, Md., was selected by the academy's general contractor, Allen & Shariff Construction Services LLC, Columbia, Md., to perform the $1.8 million roof system restoration project.

TURN TO SCAFFOLDING



In April 2011, Wagner Roofing began restoring Mahan Hall's numerous roof systems. There are three slate roof systems on Mahan Hall: a radial arched mansard roof with dormers, a gable roof over the Hart Room and a clock tower. Additionally, there is a flat-seam copper roof system above the mansard roof and a polymer-modified bitumen roof system between the mansard and gable roofs.

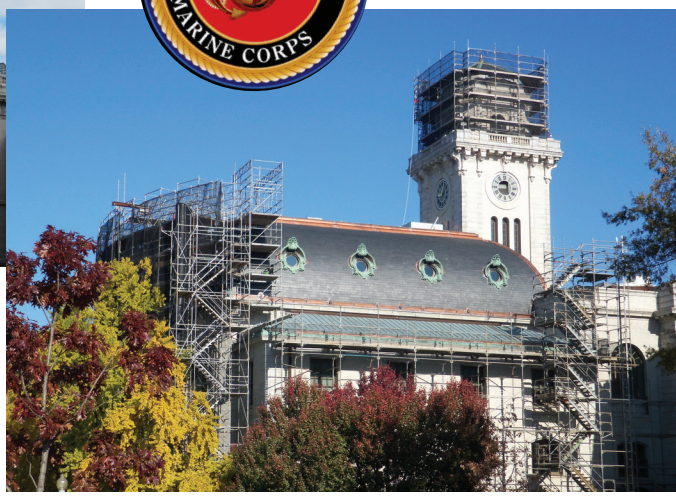
Before roofing work could commence, scaffolding needed to be constructed around Mahan Hall. Erecting scaffolding was quite a challenge—the sides of the radial arched mansard roof on the east and west elevations are directly above a standing-seam copper roof that could not support scaffolding weight, so scaffolding had to be suspended from steel I-beams and tied into the main structure of the mansard roof's scaffolding. The main mansard on the north elevation had vertical and horizontal radial curves; this is where the scaffolding's main center structure was erected and tied into the mansard roof's façade. Separate scaffolding was set on a low-slope roof to access the clock tower roof.

Per the engineered scaffolding drawings, slate was removed from the mansard roof at certain points to allow for epoxy anchors to be installed, securing the scaffolding in place. The main north and east elevations took more than one month to erect. During scaffolding erection, the drawings were revised seven times to comply with Naval Facilities Engineering Command (NAVFAC) Engineering Manual 385, which is the Army Corps of Engineer's equivalent of Occupational Safety and Health Administration regulations.

Four additional scaffolding decks were erected to cover the 32-foot-long vertical run of slate roofing from the eave to the copper bull-nose transition cornice above the mansard roof area. Ladder decks (deck hatches with foldable ladders) were installed on each scaffolding deck for access between levels, each with its own safety rail and swing-gate system. Eye wash basins, first-aid stations and fire extinguishers were placed on each deck for emergency use.

"This was a complex project with multiple areas of work and significant quantities of phased scaffolding," says Victoria Mackey, safety director and superintendent for Allen & Shariff Construction Services. "The work was [performed] from all heights, involved significant fall-protection issues and included numerous lifts. More than 21,000 man-hours were executed with no accidents or incidents."

View of multiple roofs and details, including mansard slate, suspended scaffolding, hip metal and dormers



Left to right: Mahan Hall's southwest elevation before replacement; Mahan Hall and the clock tower under construction

Per NAVFAC Engineering Manual 385, a stair tower also was installed for access and egress and strategically set where it could be reached in either direction but not farther than 75 feet from the farthest point of other access and egress points.

DEMOLITION AND PREP WORK

Mansard and gable roofs

Once scaffolding was in place, Wagner Roofing removed the slate and felt underlayment from the arched mansard roof and Hart Room's gable roof. The concrete decks then were patched, repaired and primed with Grace Construction Products' Perm-A-Barrier, followed by self-adhering Grace Ice & Water Shield® roof underlayment.

Slate on the mansard roof was installed onto wood nailers, which were preplanned and laid out so the nail holes for the slate aligned with a nailer.

Low-slope roofs

The flat-seam copper, ½-inch-thick DensDeck® and EPDM were removed from the low-slope roof above the mansard roof. Grace Ultra Ice & Water Shield then was adhered to the concrete deck, followed by rosin-sized paper, ¾-inch-thick pressure-treated plywood and 1½-inch-thick polyisocyanurate tapered insulation adhered using Firestone Building Products Co. LLC's I.S.O. Fix™ II Insulation Adhesive.

On the low-slope roof between the mansard and gable roofs, the polymer-modified bitumen was removed. Tapered insulation then was adhered to the concrete deck using I.S.O. Fix II Insulation Adhesive.

REBUILDING A ROOFING SUIT

Following tear-off and roof deck preparations, Wagner Roofing began rebuilding the roof systems.

Copper

The specifications for the flat-seam copper roof system above the mansard roof called for 20-ounce copper. In accordance with the Sheet Metal and Air Conditioning Contractors' National Association's (SMACNA's) *Architectural Sheet Metal Manual*, 1,900 sheets of 18- by 24-inch copper panels were fabricated, pre-tinned, soldered and installed. More than 1 ton of solder was used to install and pre-tin the panels.

The original roof system design failed because there were no expansion joints, so Wagner Roofing installed them at hip and ridge edges. On this roof area, workers had to maneuver around the steel I-beams from which the scaffolding was suspended.

"The sequencing of this roof along with the slate roofs, combined with the fact that scaffolding had to be in place at all times, was trying to say the least," says Kevin Morgan, project operations manager for Wagner Roofing. "But through careful planning, it was accomplished without problems, leaks or delays."

Polymer-modified bitumen

On the low-slope roof between the mansard and gable roofs, a cold-applied polymer-modified bitumen roof system was installed. This roof is split into sections and separated by an 80-foot-tall clock tower. Each area has three circular skylights that light up dual marble staircases in the building's interior between Mahan Hall's auditorium and the Hart Room's study. These circular skylights were reflashed using 20-ounce custom copper rings, soldered and secured in place around the skylight bases, and stripped in per manufacturer's specifications.

Slate

The mansard roof system installation was quite different. The slate was installed directly onto wood nailers, which were preplanned and laid out so the nail holes for the slate aligned with a nailer.

Because of the curvatures at the top of the east, west and south elevations, Wagner Roofing recommended the exposure be adjusted to compensate for the curve along one-third of these sections. Wagner Roofing was

not allowed to change the original design's installation; otherwise, it would have used a graduated pattern across the curved section, changing the slate exposure to compensate for the curve. This preferred installation method was accomplished by installing the nailers in a pattern that varied between 6½ inches and 7¼ inches over the curve. The result is a smooth transition of the same size slate across the curvature. In 1907, the slate installers used the same exposure because they nailed directly to the concrete deck.

The north elevation was more difficult because not only is there a curve at the mansard's top one-third, but there also is a side-to-side curve. Wagner Roofing cut each wood nailer ½ inch deep, and each cut was 32 inches apart. This allowed installation of the nailers on a curved surface while limiting any high edges along the nailer line.

Earthquake

During this phase, an earthquake hit the area shaking the building so hard the clock tower glass blew out on the east and west elevations. Glass shards ¾-inch-thick became embedded in the Hart Room's recently completed polymer-modified bitumen roof. Fortunately, no injuries occurred, but sections of the mansard's concrete deck broke off and had to be repaired.

As a result of the earthquake, NAVFEC engineers directed Wagner Roofing to install additional nailers anchored to the 2-inch-thick concrete purlins using Tapcon® concrete screws set 16 inches on center with Hilti 500 Epoxy Adhesive, followed by ¾-inch-thick pressure-treated plywood installed over the nailers to further stabilize the roof deck. On the mansards alone, 12,000 linear feet of 2- by 4- by 10-inch pressure-treated wood nailers, 11,250 Tapcon concrete screws and an additional 500 pieces of stainless-steel all-thread bolts were installed.

The new wood decks then were covered with No. 30 asphalt felt and North Country Slate's black slate installed with copper nails. Pressure-treated nailers were installed at the juncture of the slate mansard and flat-seam copper roofs and along the hips. The bull-nose copper and decorative ridge metal then were installed over the nailers.

TENDING THE DETAILS

After the scaffolding was in place, Wagner Roofing was able to closely inspect the 13 6- by 8-foot ornamental porthole dormers, fascia and built-in copper gutters. It was determined the 13 dormers needed restoration and the fascia and built-in gutters would need to be replaced, meaning carefully duplicating all details exactly as they were made 100 years ago.

The State Historic Preservation Office was called in to oversee and approve all the ornamental details before they could be installed. Although the 325-foot-long by 42-inch-wide built-in gutters were details that could be replaced using updated SMACNA details to improve quality and function, the ornamental fascia, containing 12 copper bells and 26 cheneaux (cresting above a cornice), had to be duplicated to the exact dimensions and details, including the location of visual vertical and horizontal seams. Often, the approval process took several weeks. Once approved, the fascia, bells and cheneux were fabricated and installed in their original locations; tolerances were within ¼ of an inch.

Project name: U.S. Naval Academy's Mahan Hall
Project location: Annapolis, Md.
Project duration: April 2011-March 2012
Roof system types: Copper; polymer-modified bitumen; slate
Roofing contractor: Wagner Roofing Co., Hyattsville, Md.
Product manufacturers: Concrete Fasteners Inc., St. Medina, Ohio; Firestone Building Products Co. LLC, Indianapolis; Grace Construction Products, Cambridge, Mass.; North Country Slate, Toronto
Gold Circle Awards categories: Innovative Solutions: Reroofing; Outstanding Workmanship: Steep-slope

The 13 ornamental porthole dormers took five workers each to remove and reinstall. In many places, the copper had worn through and most of the soldered seams had either split or cracked from weather and wear during the past 104 years. The dormers were handled carefully so they would not be further damaged.

Scaffolding surrounding the dormers had to be removed from two decks at the same time so Wagner Roofing could make an opening large enough to remove the dormers from the windows and haul them to the top deck, which was the only place they could be lowered to the ground safely. During this operation, workers were tied-off using full-body harnesses, lanyards and ropes for fall protection.

The dormers were transported to Wagner Roofing's metal shop on Ford® F350 stake body dump trucks. The dormers were so large only two at a time could be transported. Because the State Historic Preservation Office

New copper cornice being installed

Top to bottom: Each dormer took about 120 man-hours to remove, repair and install; copper details were fabricated in Wagner Roofing's metal shop; the completed flat-seam copper roof system above the mansard

wanted the dormers salvaged and rebuilt with the original patina copper for historic and aesthetic reasons, once in its metal shop, Wagner Roofing had to detail how it would repair the dormers and submit it to the State Historic Preservation Office for approval.

After hours of discussion between Wagner Roofing and Gary Voth, a sheet metal expert from Texas, it was decided to replace the circular copper window tubes and upper crickets with new 20-ounce copper and reline the backs of the dormers' ornamental façades with new 20-ounce copper because these dormer parts were the least visible from the ground and would patina quickly. Each dormer took about 120 man-hours to remove, repair and reinstall. The result is ornamental dormers that look 100 years old but are solid and waterproof.

"The most rewarding part of the project was relining the huge ornamental dormers so the existing façades stayed but all the integral inner flashings were new," Morgan says.

A radial dormer and a shed dormer on the Hart Room did not need to be replaced but needed new copper base flashings. The existing copper along the bases was carefully removed, and new copper flashings were installed. Because there weren't nailers or a wood deck on the original roof's concrete deck, the copper dormers needed to be modified to compensate for the change in deck height. Wagner Roofing accomplished this by cutting away the existing copper at the dormers' bases and fabricating and installing a copper-cleated counter that locked to the original copper wall panels. On one side of the shed dormer, a recessed copper trough was created to allow water to properly shed onto the new flat-seam copper roof.

Once the slate and dormers were installed, Wagner Roofing's sheet metal department fabricated and installed the 20-ounce copper radial hip cap and two-piece bull-nose transition cornice/apron along the top of the mansard. Both details were duplicated to exact dimensions but were installed using a more secure hidden-cleat method than originally had been used.

ON *the* WEB

For information about Alfred Mahan, log on to www.professionalroofing.net.

THE CLOCK TOWER

Wagner Roofing also repaired the clock tower. Work consisted of repairing weathered Buckingham slate and a copper weather vane and replacing half-round gutters, lead-coated copper water tables and a flat-seam lead-coated copper roof.

Wagner Roofing's team worked with the masons, who were repointing the brick and replacing the clock tower's stone ornamental urns. The lead-coated copper water tables were fabricated on-site and replaced as the masons replaced the stone urns.

The flat-seam copper roof had multiple angles, and the clock tower's open configuration was challenging. About 90 percent of the lead-coated copper panels were mitered with angle cuts. The clock tower also had a bell NAVFAC silenced for one month while work was being performed.

DOWN THE HATCH

After installing 9,700 square feet of slate, 4,700 square feet of flat-seam copper, 2,500 square feet of polymer-modified bitumen, 475 linear feet of copper built-in gutters and 275 linear feet of ornamental fascia, Wagner Roofing completed its work in March 2012. Working around the academy's activities, including a graduation, Wagner Roofing delivered exceptional workmanship and metal work that replicated the way it was performed more than a century ago.

"This was a major once in a lifetime roof replacement on one of our most prominent and revered historic buildings," says Randolph Ghertler, Naval architect. "It was a privilege to work with Wagner Roofing. Their employees and project managers did an outstanding job on this complicated project."

For its efforts on Mahan Hall, Wagner Roofing received an unprecedented three 2013 NRCA Gold Circle Awards in the Innovative Solutions: Reroofing category; Outstanding Workmanship: Steep-slope category; and the Platinum Award for superior workmanship and project presentation.

"It was probably the most challenging job I have worked on during my 44 years of roofing, and I am grateful for the great work performed by Kevin Morgan, Sarah Reynolds and Sheila Wagner in our office," says Chuck Wagner, president of Wagner Roofing. "My grandfather and father would be proud of our company's accomplishments at Mahan Hall and especially proud Wagner Roofing is celebrating 100 years in business."

CHRYSTINE ELLE HANUS is *Professional Roofing*'s associate editor and NRCA's director of communications.