Waterproofing Challenge:

World Trade Center *Reflecting Absence* Fountains

By Nick Leuci

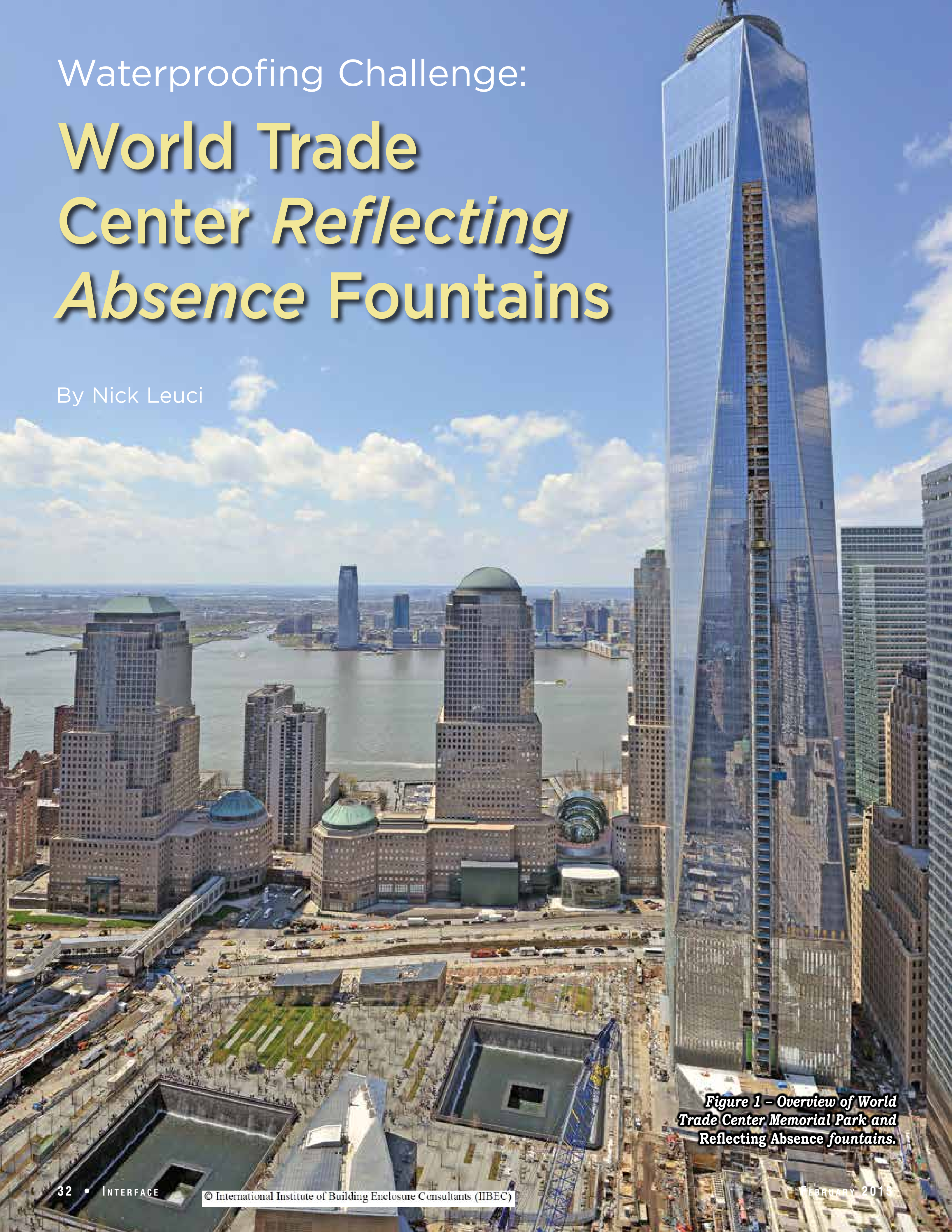

Figure 1 – Overview of World Trade Center Memorial Park and Reflecting Absence *fountains.*

When North America's largest man-made waterfalls were being designed at the World Trade Center (WTC) site in New York City, many different obstacles were present. Not only were the architects dealing with the day-to-day struggles of a large construction project in the downtown of one of the biggest cities in the world, but this project also hit close to home. While the United States was still mourning the tragedy of 9/11, an appropriate memorial needed to be designed and built in the victims' memories. The winning design, selected from a large competition entitled *Reflecting Absence*, was designed by architects Michael Arad and Peter Walker. The four-acre memorial includes a plaza level with two large fountains that occupy the footprints of the former twin towers (*Figure 1*).

The fountains would consume approximately an acre of real estate for each pool. Water cascades 30 feet down into the first stage of the pool (the upper void), and then falls another 21 feet into the center of the pool (the lower void). The fountains are surrounded by a 12-acre park that provides a serene setting. Visitors to the site are engulfed in the sound of the waterfalls as they approach the fountains (*Figure 2*).

There is a very limited amount of space present at the WTC site. The importance of the waterproofing becomes evident when you consider that below the pools are a subterranean museum, the Path tracks (*Figure 3*, the heavy rail-rapid transit trains that make up the primary link between Manhattan and neighboring New Jersey), and the physical plant for Towers 1-4. Keeping these structures free of water was an engineering feat that required high-performance materials and a team of experts that understood how to address the difficult details of the construction.

Davis Brody Bond, LLP, the architect of record, retained the services of Wiss, Janney, Elstner Associates, Inc. (WJE) to consult on the waterproofing. The design team gave careful consideration to the complex details of the project and the extreme environment. The waterproofing installed on the fountains would be subject to many difficult conditions. Therefore, a high-quality, high-performing waterproofing membrane was needed to ease the concerns of the owners and architects involved with the job.

Most waterproofing products can keep structures watertight but have many physical and chemical limitations. These limitations can be related to exposure to environments that contain UV light, chemicals, or traffic. Many traditional materials are also limited by application temperature. There are also "waterproofing" systems that are not suitable for immersion environments or use where ponding water is present. Finding a system capable of withstanding all these conditions was a challenge.

Ultimately, a waterproofing specification was written based on a two-component, asphalt, modified-polyurethane system designed for use in tough environments. The specified system was chosen for its combination of performance properties, which would be critical to the success of the waterproofing. These properties included UV stability, ability to cure quickly in warm and cold environments, chemical resistance, abrasion resistance, and potable water approval. In order to minimize the risk of failure, other non-material characteristics were also evaluated during the product selection process. These characteristics included proven track record, high level of technical field support, and references for projects with similar or more demanding conditions. Products that met the criteria of the spec, and which were ultimately installed, were CIM 1061 and CIM 1000 Trowel Grade by C.I.M. Industries, Inc.

Due to the demanding construction schedule, the waterproofing installation was set to commence in late winter and would be directly exposed to the environment during construction. An aggregate surfacing and two layers of protection board were specified for areas where heavy construction traffic would occur over the membrane to help prevent damage during construction.

The installation was performed by KJC Waterproofing, Inc., a local waterproofing contractor. KJC had limited experience applying the specified materials. In order to increase its knowledge of the waterproofing system and to ensure proper installation techniques, the company sent several employees that would be intimate with the WTC project to the manufacturer's training course. Several members of the design team also attended the training program.

The waterproofing contractor spent over 18 months on the project to complete the installation of the waterproofing systems. This included the hot, rubberized asphalt used for the plaza, as well as the system that was applied to the memorial pools.

The entire installation was performed by hand, using squeegees, trowels, and rollers. The project team agreed that these methods would provide the most efficient means to a successful installation.

The alternative method of application is to spray-apply the waterproofing materials. Application of polyurethane materials by airless spray creates airborne particulates that can be hazardous to nearby workers and occupants of adjacent properties. Spray equipment can

Figure 2 – Visitors' view into the pools and surrounding buildings.

Figure 3 – The WTC is arguably the most important stop on the PATH rail system. The rails run directly below the pools, increasing the need for a high-performance system that will not leak.

also be difficult to operate and maintain in subfreezing temperatures. The greatest advantage to spray equipment is ease of application on vertical and overhead surfaces. The fountains contained limited vertical surface and almost no overhead surfaces that required waterproofing.

Different surface preparation methods took place throughout the application because of varying substrates, conditions, and access. Surfaces were abraded using hand and power tools, abrasive blasting, shot blasting, and water blasting. Concrete surfaces required a profile equivalent to ICRI CSP 4-6, and steel surfaces required an SSPC SP-10 with a minimum 2- to 3-mil profile. These requirements are standards for surface roughness and cleanliness. ICRI CSP 4-6 (the International Concrete Repair Institute's concrete surface profile) is equivalent to a light-to-medium scarification for systems that are 50 mils to 1/8 in. or more in thickness. SSPC SP-10 (the Society for Protective Coatings' surface preparation guideline) is a level of cleanliness for steel with no mill scale, loose material, coatings, and less than 5% staining.

Installation of the waterproofing systems actually began well before the memorial pools were erected. The first structures to receive the waterproofing were the fire-protection water storage tanks, in 2005. Construction of the pools took several years; and finally, in March of 2009, they were ready to receive the waterproofing. KJC began the installation on the lowest portion of the North Pool, the lower void. Per the specification, a total of 120 dry mils of product were to be applied. The waterproofer elected to use the trowel-grade product on the walls and the self-leveling system on the floor. Inspection of the waterproofing confirmed that the minimum thickness requirement was met, with an average of 150 dry mils on all surfaces of the lower void of the North Pool.

The contractor then proceeded to waterproof the main portion of the pools, the walls, and the floors of the upper pools. First, the bottom 4 ft. of the upper pool walls was coated with the trowel-grade product in a single coat. The material was extended onto the floor 12-18 in. to be eventually tied into the self-leveling product that would be applied to the floor. The upper portions of

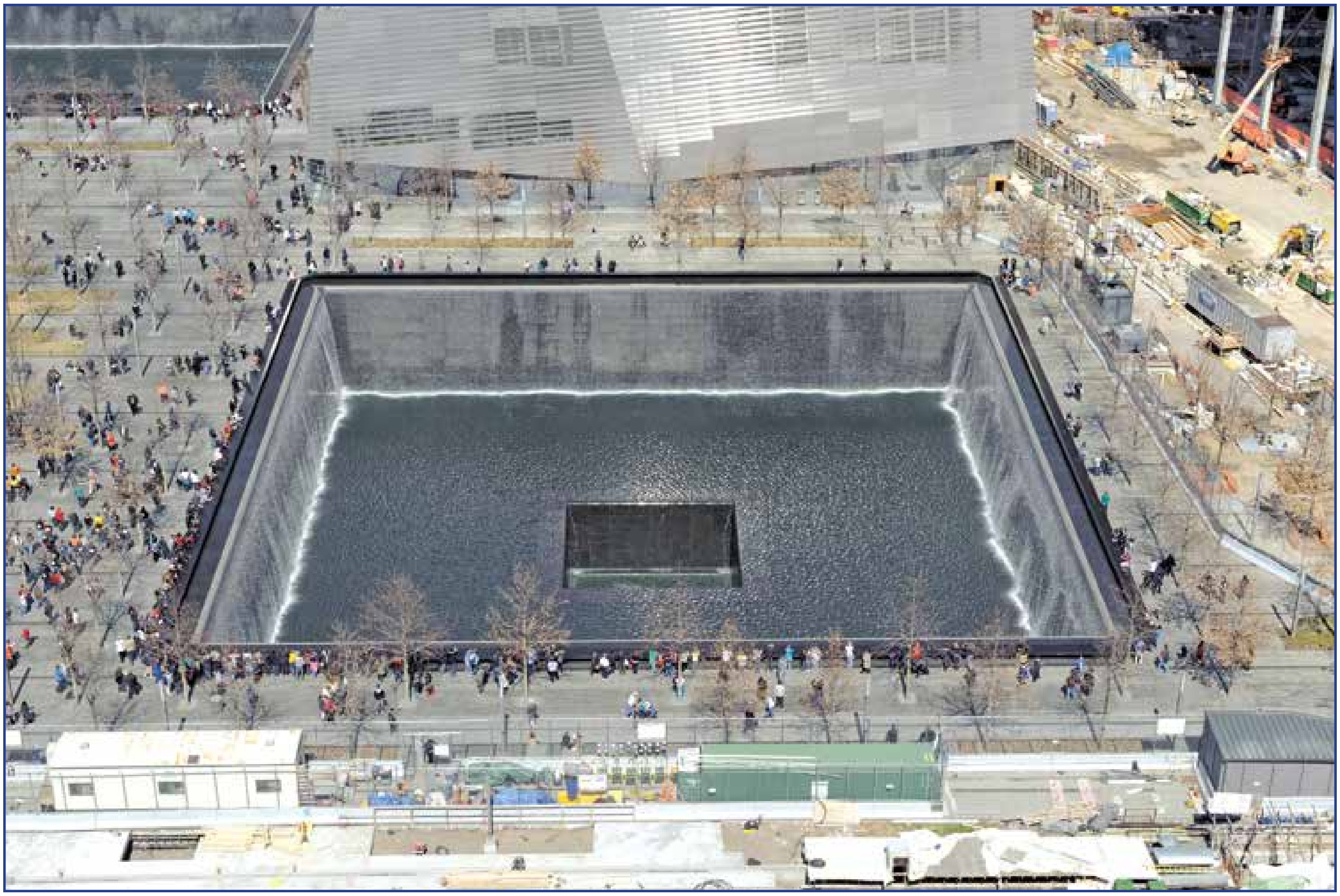

Figure 4 – Hot rubberized asphalt waterproofing on plaza that surrounds each fountain ties into the two-part urethane used to seal each of the pools.

the walls were then sealed.

The floors consisted of large, open, horizontal spaces. A portion of the floor was constructed using precast concrete planks. The planks contained several joints that required special treatment prior to installing the 120-mil waterproof layer of waterproofing material. The self-leveling and trowel-grade products were used to create slip joints in these areas prior to flood-coating the floor. The floor was marked off in a grid to assure that each 5-gallon unit of waterproofing covered the correct amount of feet to result in a minimum thickness of 120 dry mils. The product was squeegee-applied, and up to 10,000 ft. per day was applied, depending on access within the fountain.

The two-part waterproofing system cured to form a tough, durable, rubber lining over-

Figure 5 – Plates surround the fountain with the names of the victims. There are numerous penetrations through the waterproofing to provide the heating and cooling for the plates.

night. The following day, workers were able to work on the waterproofing without damaging it, and materials would be moved onto the membrane to clear space in the pool for the next portion of concrete to be coated.

The materials that were stored on the waterproof membrane included insulation and pallets of heavy marble panels that were eventually placed over the waterproofing and provided the finished surface of the pools. The weight of these pallets did not damage the tough polyurethane system.

One of the biggest challenges that faced the team was how to address sealing around several thousand support brackets on the walls used to hold up the marble panels. It was not feasible to install the brackets prior to installing the waterproofing, so a process was put in place to seal around the brackets after they were installed through the previously applied waterproofing. The surrounding 2-3 inches of waterproofing material around each bracket was abraded, treated with a bond enhancer, and sealed with a caulkable version of the trowel-grade product.

The final portion of the installation occurred at the top of the pools. The waterproofing was installed to the interior of the troughs under the plates that contain the names of all the victims of the World Trade Center tragedy and extended 4 ft. down the interior vertical wall. Within the troughs are adjustable stainless steel weir plates that are used to create an unbroken cascade of water that falls into the upper pool. The weirs needed to be able to be adjusted after the waterproofing installation was complete to fine-tune the shape and look of the falling water. In order to create a seamless seal from the concrete to the stainless steel and back to the concrete on the interior of the pool, a combination of the waterproofing and a preformed joint from Situra was used. C.I.M. tested compatibility of the waterproofing with the joint material and assisted in the design of the moving joint, which consisted of several layers of the waterproofing system, fabric reinforcing, and the preformed joint system.

Opposite the weir on the exterior of the troughs, it was necessary to marry the waterproofing with a hot rubber system used to waterproof the memorial park. A multi-layer detail consisting of the fountain waterproofing, uncured neoprene, and hot rubber was used. This particular detail contained numerous layers to provide waterproofing redundancy at this critical juncture (*Figure 4*).

Other details—such as tie-ins to penetrations, drains, and conduit—were kept to a minimum. With the exception of the water supply pipes and drains, all penetrations in the fountains were kept above the service levels of the pools. Penetrations occur above the water level and then branch down, concealed by a nameplate parapet and stone cladding to where they are needed within the pools. Where penetrations did occur below the water level, the trowel grade was used to form a self-terminating seal to prevent water intrusion in these areas (*Figures 5* and *6*).

The entire application was repeated in the South Pool. During the installation, the waterproofing was left exposed to all four seasons. The temperatures ranged from freezing temperatures to hot and humid summer days. Application of the waterproofing was performed in a similar range of temperatures.

The installation of the waterproofing system was closely monitored by the design

Figure 6 – Troughs and penetrations are hidden from view behind horizontal marble panels. The waterproofing system ties into the stainless steel weirs, which are fully adjustable to control the flow of water into the fountain.

team, the manufacturer, and by a full-time third-party inspection firm. In order to assure that the waterproofing was monolithic and contains zero leaks, several inspection techniques were used throughout the project. High-voltage testing was performed on vertical portions of the fountains, low-voltage testing was performed on horizontal portions, and visual inspections were performed on all portions of the project.

The number-one cause of premature waterproofing failure is poor adhesion. Throughout the installation of the waterproofing materials, field adhesion tests were performed to assure that a minimum of 15-pli adhesion was obtained. In most cases, the adhesion far exceeded the minimum requirement, with a cohesive failure in the substrate or the waterproofing. Any deficiencies in the coating were repaired as work progressed from day to day.

The waterproofing needed to be completely installed by early 2011 in order for other trades to complete the work on the fountains for the 10-year anniversary of the September 11th tragedy. The waterproofer successfully completed the installation of the fountain waterproofing in the spring of 2011, and the memorial opened on schedule on September 11, 2011. The oldest portions of the waterproofing installation are approaching 10 years of age, and many portions of the pools have passed the five-year mark. There have been no reported leaks in the waterproofing, and it is expected to last a lifetime, as designed.

Nick Leuci

Nick Leuci is the technical manager for the construction business unit of Chase Corporation, headquartered in Bridgewater, MA. Prior to his current role, he was the national sales manager for C.I.M. and has had over 17 years in technical sales experience in the industrial coating, linings, and waterproofing industry. Leuci is currently responsible for all OEM construction business, the manufacturer/contractor training program, and research and development support. He holds a bachelor's degree in business management from the University of New Hampshire in Durham.

RCMA Merges With RRCI

The Roof Coatings Manufacturers Association (RCMA) and the Reflective Roof Coatings Institute (RRCI) have merged into one industry association. Members hope that bringing the two associations together will "better position the roof coatings industry in the various legislative, regulatory, and building code development arenas that affect the two associations' consolidated membership." In addition, the merger is expected to result in a more detailed and comprehensive industry shipment report that will be a benefit to members.

RCMA has recently created the RCMA Reflective Roof Coatings Institute, which will develop technical bulletins, case studies, white papers, and research intended to be technical and educational resources for the industry.

RCMA will hold its annual meeting in New Orleans, LA, February 22-23, 2015, in conjunction with the International Roofing Expo.

The association will continue to be called the Roof Coatings Manufacturers Association. For more information, visit www.roofcoatings.org.

