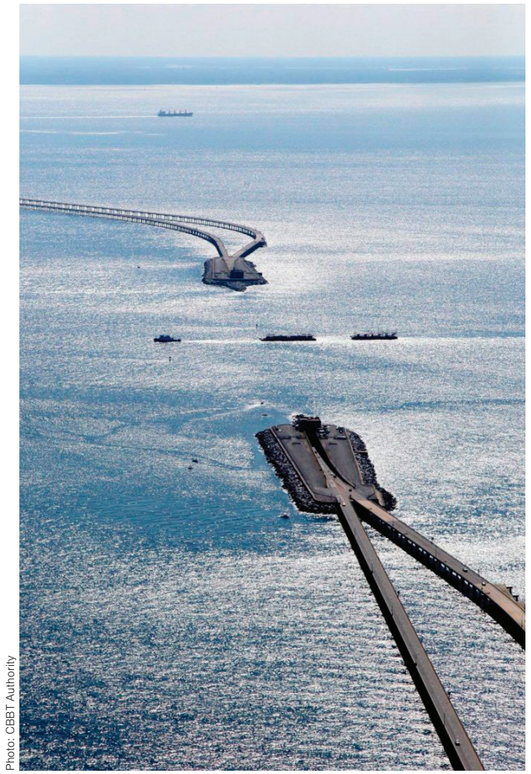

Photo: CBBT Authority

WONDERS NEVER CEASE

Custom tunnel luminaires help transport an 'engineering wonder' from the 1960s into the 21st century

By Paul Tarricone

When it opened in April 1964, the Chesapeake Bay Bridge–Tunnel (CBBT) was selected as "One of the Seven Engineering Wonders of the Modern World," and to this day it remains one of only 11 bridge-tunnel systems in the world. Each year, more than 4 million vehicles cross this 17.6-mile U.S. southeast coast travel route that connects Northampton County on the Eastern Shore with Virginia Beach, Norfolk, Chesapeake and Portsmouth on the Western Shore. Part of that journey includes two 1-mile tunnels—the Chesapeake and Thimble Shoals Tunnels. These two tunnels are critical in that they allow ships to cross the water in the gap between the bridges in order to access the Atlantic Ocean.

But what was an "engineering wonder" in 1964 had grown creaky on the inside some five decades later. Due to the tunnels' aging infrastructure, the CBBT Authority undertook a three-year equipment overhaul to restore and improve the tunnels' critical systems.

For the tunnel roadway lighting, 2,835 LED luminaires (Kenall) have replaced linear fluorescent luminaires. CBBT Authority Director of Maintenance Tim Holloway describes the new LED system as "a long overdue solution to highly repetitive and costly tunnel re-lamp lane closures, with savings on power consumption being the icing on the cake." Chase Sturgis, the CBBT's electrical/mechanical superintendent who led the replacement effort, adds that the transition to LED "ensures that the CBBT is taking steps in the right direction to keep pace with an evolving industry." All told, the 5000K/70 CRI LED system is expected to save $500,000 per year in energy consumption and maintenance costs.

High-quality tunnel lighting and energy savings were the payoff of a painstaking engineering process that had to consider site conditions and the need for a custom product solution. Indeed, the owner had a detailed list of project requirements that included meeting or exceeding current light levels and uniformities, adherence to IES RP-22 recommendations, and improved visibility in the tunnel to ensure low disability/discomfort glare for public safety.

The Authority also homed in on fixture design criteria, says Michael Maltezos, transportation sales manager for Kenall, who handled design for the project. "The Authority wanted to acquire robust fixtures of top-notch quality with little to no maintenance. It also wanted to improve upon the existing fixtures' shallow profile, to prevent trucks from hitting and damaging fixtures due to very low ceiling clearances."

A tidy wish list. There was just one problem. "The product we needed simply did not exist," says Holloway. "Kenall worked hand-in-hand with us to develop the product and then further refine it in the field."

Photo: Kenall

Photo: Kenall

Opposite: The tunnels between sections of the bridges allow for unimpeded traffic flow in two shipping canals leading to the Atlantic Ocean.

Above: The 5000K/70 CRI LED luminaires were custom-designed for this project.

Not surprisingly, site conditions inside the tunnels dictated product design. "The tunnel lighting was designed as a one-for-two replacement of the existing continuous linear fluorescent tunnel luminaires," Maltezos explains. "More specifically, all the existing luminaires were ceiling-mounted near the tunnel walls, where the adjacent continuous linear wireway would be reused to feed the replacement luminaires; accordingly, all of the new luminaires would have to physically fit within the existing ceiling-mounted luminaire footprints."

Further, the LED luminaires would have to provide the required light output in all the tunnel zones—particularly in the Threshold Zones—without overheating. "This was no small feat," Maltezos says, "particularly in the Threshold Zones where the new fixtures would be replacing 500-W fluorescent luminaires. Higher-output LED fixtures, 300 watts and above, inherently produce a fair amount of heat, particularly in a ceiling-mounted application. Add to that, the fact that the ceiling-mounted LED replacements would require an even shallower profile (less than 3 in. total) than the existing fluorescent fixtures. Suffice to say, this was a huge concern. In fact, at the time of design, no luminaire manufacturer, including Kenall, could make such a shallow-profile, high-output LED tunnel fixture that would pass a heat test in a ceiling-mounted application without some sort of substantial heatsinking."

To mitigate the heat, the company designed custom heat sinks for the LED drivers. This, combined with the new fixture housing's shallow profile (2.5 in.) and linear design for airflow, allowed the fixture to operate at a relatively low temperature despite its location on the ceiling deck. Trial runs were critical, says Maltezos. "We engaged in multiple iterations of driver testing at our test lab to replicate actual conditions in the tunnels, and performed exhaustive heat testing on the fixtures to verify passing thermals in simulated field conditions and not just in typical ambient lab conditions."

Meanwhile, the LED luminaires also had to include cord sets to match those currently plugging the existing wireway. As a result, the length of the new fixtures had to correspond with the existing cord-set locations.

Photo: Kenall

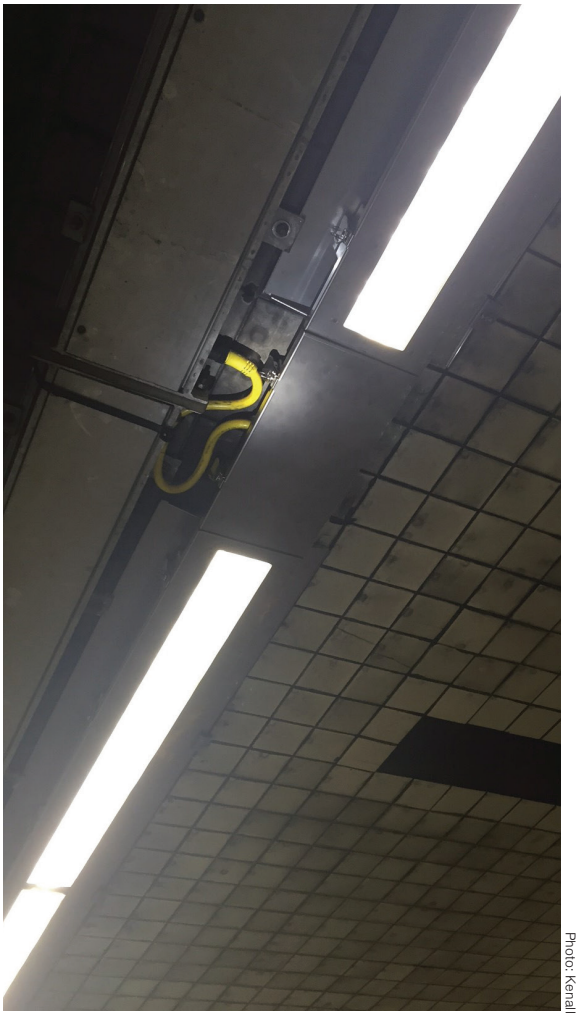

Photo: Kenall

Left: Custom heat sinks, a shallow housing profile and linear design for air flow allows the fixtures to operate at a relatively low temperature.

Right: The units are built to fit in terms of longitudinal locations of the cord sets on the fixtures, as well as cord-set lengths and clearances between the fixtures and the adjacent wireway.

At A Glance

- $500,000 per year in energy and maintenance savings are forecast.
- 2,835 luminaires were installed in two tunnels.
- Luminaires were replaced on a one-for-two basis.

Mounting-rail locations were the next detail. "All replacement luminaires needed to have a completely customized mounting design, to fit right onto the existing wireway's mounting rail pattern," notes Maltezos. "In short, exact locations of the LED luminaires' mounting rails and cord-set feeds had to be coordinated with existing conditions on the tunnel wireway, yielding a plug-and-play application."

Finally, the level of customization extended even to the mounting brackets. Further complicating the custom design to fit the existing wireway mounting rail was the fact that the other side of the fixtures required conventional mounting tabs to be anchored into the ceiling deck. As such, the company coordinated with the CBBT to manufacture further customized versions of the fixtures, so the mounting tabs would fit perfectly in locations where anchors had not been previously drilled into the ceiling deck and would therefore be structurally stable after installation.

To address these site-specific challenges, Kenall designed a more compact luminaire to fit the existing footprint, and yet still maintain accessibility of component parts for servicing. Using the same smaller physical design/footprint for all fixtures in the project's various tunnel zones has minimized the types and quantities of replacement fixtures/parts to be stocked by CBBT maintenance personnel.

The majority of the installation was completed in mid-2020, with final installation nearing completion. A modern tunnel lighting system for a former—and perhaps future—"Engineering Wonder." ◎

THE DESIGNER | Michael N. Maltezos, Member IES, is the transportation sales manager for Kenall and a member of the IES Street & Area Lighting Committee and Roadway Lighting Committee, and is also a member of the CIE's Liaison Committee with the IES.