

# 'Leaning' on Prefabrication

Lean construction techniques, spearheaded by prefabrication, drive design-build success at D.C. bus garage.

BY AMEEN KHOURI

A growing number of construction firms are embracing lean construction techniques that aim to maximize value for the customer by eliminating or minimizing waste at every opportunity. For Rockville, Maryland-based mechanical contracting firm Shapiro & Duncan, lean construction often comes together, literally, at its offsite prefabrication facility in Landover, Maryland.

In operation since 2007, the 52,000-square-foot building on eight acres is outfitted with the precision equipment and advanced systems needed to produce time- and waste-saving prefabricated pipe assemblies.

Prefabrication proved to be one of the keys to success on Shapiro & Duncan's largest-ever design/build project (\$21 million) — the 335,000-square-foot Washington Metropolitan Transit Authority's Andrews Federal Center Bus Garage. It serves as a major hub for WMATA's heavy bus operations in the metro Washington region, including the District of Columbia and its Maryland and Virginia suburbs.

Supporting a fleet of 1,600 buses, it has more than 100 bays for fueling, repairing and painting buses. The facility also provides ample office space for WMATA employees.

Any design/build project poses a challenge because it requires taking design requirements from the owner, turning them into a constructible deliverable and then building what is designed. In this case, the Shapiro & Duncan team was breaking new ground by designing mechanical and plumbing

Shapiro & Duncan covered 52,000-square-feet of the pre-fab shop's roof with 925 PV solar panels to meet 100 percent of its energy needs. Photo credit: Shapiro & Duncan



systems for its first large-scale industrial facility.

One such challenge was taking design requirements used on older WMATA vehicle platforms and bridging them to the agency's current equipment performance (e.g., hybrid bus engines). For example, the RFP documents lacked detailed requirements on the owner's compressed air needs, which resulted in a significant upsizing of the system.

The 529-day delay at the start of the project posed another challenge. The site originally chosen by WMATA was under an EPA moratorium because the site's infrastructure was overtaxed environmentally. Subsequently, permits could not be obtained from Prince Georges County, Maryland, and the Washington Suburban Sanitary Commission. Before the mechanical contractor could start work, WSSC performed several

major renovations at wastewater pumping stations to avoid allowing effluent to make its way into the environment.

Stopping and starting a mechanical systems project always creates challenges. In design/build mode, it helps when construction occurs at a continuing pace, which allows the design team to make fluid changes on the fly.

## BIM, prefab Solutions

The mechanical solution for WMATA stemmed from Shapiro & Duncan's willingness to dig into the details of the transit agency's current bus fleet and help the client define its actual system needs. The contractor brought several newer WMATA buses to the site and tested their exhaust in various modes. This proved to be the key to meeting the original intent of the project requirements.

The mechanical contractor was hired to manage and oversee the entire 3D building information modeling process on behalf of the general contractor. Shapiro & Duncan's Virtual Design and Coordination team succeeded in coordinating all the major systems to be installed in the large facility — heating and cooling, fuel and lubrication, vehicle lifting and overhead cranes to move equipment around the shop.

The 335,000-square-foot Washington Metropolitan Transit Authority's Andrews Federal Center Bus Garage has more than 100 bays for fueling, repairing and painting buses. Photo credit: Shapiro & Duncan



The VDC team was able to interweave all these systems into the building with adequate clearance to function as intended — even when faced with project delays that caused stopping and starting on the job, and the need to re-coordinate some design elements based on changing field conditions.

In keeping with lean construction principles, the prefabrication team weighed in as part of the solution. Most of the piping needed for the job was prefabricated and sent to the jobsite for just-in-time installation.

With its state-of-the-art equipment and staff of qualified employees, Shapiro & Duncan's fabrication shop can accurately fabricate and assemble any type of piping configuration from the simplest riser to complex mechanical and boiler rooms. The controlled environment in the fab shop enables it to maintain a high degree of quality and a constant level of productivity, regardless of weather or project site conditions.

Prior to any fabrication, the fab shop team processes coordinated drawings provided by the VDC team to produce the necessary detail — making certain all prefabricated items will properly fit within the mechanical design. All drawings are then reviewed and approved on the jobsite. Once fabrication begins, communication continues between the fab shop, CAD operators and jobsite.

### Successful Results

Shapiro & Duncan's project team succeeded in taking WMATA's design requirements and translating them into a structure that serves WMATA's modern-day bus fleet maintenance needs.

The full list of mechanical system components includes:

- 29 rooftop makeup air units;
- 4 rooftop energy recovery units;
- 5 rooftop air-handler units;
- 5 hydronic boilers;
- 101 blower curtain units;
- 27 emergency exhaust fans;
- 12 vehicle exhaust fans;
- 29 exhaust fans;
- 14 hydronic pumps; and
- A radiant flooring system for the fuel and wash building.

In a final flourish, upper management of general contractor Hensel Phelps Construction Co. pointed out that although its company had built several similar industrial facilities before, this project was the most aesthetically

pleasing to date.

Such a "lean" mechanical solution would not have been possible without prefabrication. On the Andrews Federal Center Bus Garage project, Shapiro & Duncan's prefab capabilities got the team rolling on the route to lean construction success. ●

*Ameen Khouri is a senior project manager at Shapiro & Duncan Mechanical Contractors in Rockville, Md. A third-generation family-owned business, the company has been serving customers in the D.C. area since 1976.*

*For more information, visit [www.shapiroandduncan.com](http://www.shapiroandduncan.com).*

## Coal Power to Sun Power

BY MARK DRURY

In 2002, Shapiro & Duncan made its first step into the prefabrication of piping assemblies with a 12,000-square-foot leased facility in Beltsville, Maryland. Soon discovering that it needed more space, the company in 2007 purchased a 52,000-square-foot building on eight acres in Landover, Maryland, with an eye toward becoming an industry leader in prefabricated pipe assemblies.

In 2018, the Prefab Shop team moved forward with several projects to enhance the shop's capabilities, including the transformation from coal-fired electricity to solar power to make it self-sufficient in its energy supply.

Working in partnership with Columbia, Maryland-based Aurora Energy, a commercial solar project developer, the Shapiro & Duncan team met this challenge by covering 52,000-square-feet of the roof with photovoltaic solar panels.

Aurora Energy started the project by obtaining interval data for the facility that showed the exact kilowatt-hour (kWh) draw and demand draw. This data led to a determination of the electrical output required by the solar power system.

The result is a system with 925 SunPower solar modules, mounted on a Panel Claw support system, plus three SolarEdge power optimizers. The system is rated to produce 302 kilowatts of solar power and almost 400 megawatt hours of energy per year. This solar power output is sufficient to meet 100 percent of the prefabrication facility's energy needs.

The solar panels feed into a SolarEdge dashboard, directly connected to the grid at a new dual-direction electrical meter, which provides a real-time view of building load energy consumption versus energy production. The system has a 25-year lifetime guaranty and the initial capital investment will be recouped in less than six years. Over the life of the system, it will save almost \$2 million in energy costs.

Taking this step was not only a smart investment of company capital with a tremendous return but also the right thing to do for the planet by switching from coal power to sun power. The system went live on Dec. 28, 2018, and is already making a positive impact on the environment, generating 96 megawatts to date. This change in energy source has saved 149,000 pounds of CO<sub>2</sub> emissions, which is the equivalent of planting more than 3,700 trees.

Additional improvements to the prefab facility:

- Construction of a 4,800-square-foot, three-sided metal storage building used for storing finished prefab assemblies as well as ladders and gang boxes. With racked shelving, the new building doubles the area's storage capacity while adding the benefit of the items being under the roof.
- Replacement of the 20-year-old tar and gravel roof with a white thermoplastic polyolefin roof system over two layers of insulation and hardboard. The additional insulation improves winter heat retention and the white surface reflects the sun's rays in the summer to keep the building cooler.
- Inside the shop, the addition of a second Vernon CNC plasma pipe cutting and profiling system, which doubles steel line capacity while increasing the range of pipe sizes from 48-inch diameter down to a 2-inch diameter. The machine will cut and bevel straight, saddle, tee, multi-miter, lateral, multi-saddle, gusset slots, double miter, pipe to cone, bumpers and overlaps.

*Mike Drury is the vice president of business development at Shapiro & Duncan.*