White Paper: Lessons Learned on the Arlington Transit Shirlington Operations and Maintenance Facility Project

December 2025

DRPT
VIRGINIA DEPARTMENT OF RAIL AND PUBLIC TRANSPORTATION

ART
arlington transit

stv

In this white paper you will learn about:

1. **Coordination efforts and strategies utilized with key stakeholders.**
2. **Considerations for the design of battery electric bus (BEB) charging infrastructure.**
3. **Considerations for the use of the Construction Manager at Risk (CMAR) delivery method for a bus operations and maintenance facility.**

Highlights

- **To ensure a successful project completion, while minimizing risk, coordination between all key stakeholders must be initiated early and often.**
- **The Project Team must develop design criteria for BEB charging operations early on as a first order of business.**
- **It is critical when initiating BEB infrastructure design to understand the planned site from a wholistic point of view.**
- **The CMAR project delivery method involves the contractor early on, before much of design has taken place. This results in enhanced cost certainty and a need for independent cost estimating to ensure value-for-money.**

Introduction

Capturing both the positive and negative experiences or lessons learned of a project should be an ongoing effort throughout the life on every project. This white paper is intended to document the lessons learned from the Arlington Transit (ART) Shirlington Operations and Maintenance Facility Project (AMOF Project) in Arlington County, VA. The AMOF Project was led by Arlington County and Arlington Transit and funded through the Virginia Department of Rail and Public Transportation (DRPT), the Northern Virginia Transportation Authority (NVTA), and local sources. DRPT also maintained an oversight role to monitor progress on the project.

The AMOF Project included a new bus operations and maintenance facility, battery electric bus (BEB) charging infrastructure to support up to 47 buses, photovoltaic (PV) panel infrastructure, surface parking for up to 61 buses, and a multi-level parking structure for up to 110 employee vehicles. The purpose of the AMOF Project was to construct the facilities needed to consolidate ART's service functions and support its current and future needs.

This white paper focuses on the following lessons learned from the AMOF Project:

- Coordination efforts and strategies utilized with key stakeholders
- Considerations for the design of BEB infrastructure
- Considerations for the Construction Manager at Risk (CMAR) delivery method

Background

Arlington Transit (ART) operates a fixed-route bus service that includes fourteen (14) routes within Arlington County, VA. In 2024, ART had an annual ridership of approximately 2,500,300. Over the past 10 years ART has significantly increased its number of routes and hours of service and plans to continue growing over the next 20 years. The new facility serves as a permanent home for the buses that were formerly stored in space leased by ART in the Alexandria section of Fairfax County. The lease for this space expired in June 2025. The new facility is located at 2631 and 2635 Shirlington Road in Arlington County, VA. Arlington County required a minimum of LEED Building Design + Construction (BD+C) Silver Certification for the Project.

In July 2018, the Arlington County Board approved the purchase of three parcels on S. Shirlington Road for $23.86 million with the intention of using it for the new facility. The AMOF Project was initially approved in Arlington County's FY 2019-2028 Capital Improvement Plan for $81.2 million, which included the cost of the land for the proposed facility, concept planning, design, and construction. Over $20 million of this total originated from state funding sources. The initial project budget of $81.2 million did not include the cost of the actual BEB charging infrastructure or the PV panel infrastructure as these components were added later as discussed below. In September 2020, Arlington County approved a $3.9 million contract with Stantec Architecture, Inc. for planning, design, and construction administration services for the new facility. Arlington County delivered the construction of the AMOF Project using the Construction Manager at Risk (CMAR) method. In May 2022, Arlington County approved a contract with Turner Construction Company to serve as the CMAR for the new facility. Construction of the project started in June 2022.

In April 2023, the Arlington County Board initiated a change in scope to update the facility design to allow the facility to support a 100% BEB fleet and PV panel infrastructure. The Board approved

a contract increase with Stantec Architecture, Inc. to include additional design and construction administration services for the BEB charging infrastructure and PV panel infrastructure. In February 2024, Arlington County submitted a Making Efficient and Responsible Investments in Transit (MERIT) grant application to the Virginia Department of Rail and Public Transportation (DRPT) for construction funding for the BEB charging infrastructure and the PV panel infrastructure. Arlington County was subsequently awarded $12.3 million in state funding for the BEB charging infrastructure and PV panel infrastructure.

Due to the addition of the BEB charging infrastructure and PV panel infrastructure to the scope for the AMOF Project, the project was split into two phases. Phase 1 included the site improvements, the new bus operations and maintenance facility, a canopy to support the BEB charging infrastructure and a portion of the PV panels, and the employee parking structure. Phase 2 included the BEB charging infrastructure and PV panel infrastructure on the canopy and the roofs of the bus operations and maintenance facility building and the employee parking structure. Substantial completion of Phase 1 of construction was achieved in the fall of 2024. ART occupied the new facility in December 2024. At that time the CMAR demobilized from the site while awaiting the delivery of long lead items related to the BEB charging infrastructure and PV panel infrastructure. Phase 2 construction started in March 2025 and is anticipated to be fully complete by the end of 2025.

Coordination Efforts & Strategies with Key Stakeholders

Coordination with Dominion Energy and Washington Gas

Dominion Energy (Dominion) was identified as a critical stakeholder at the beginning of the AMOF Project as the new facility would require adequate power for several major components, including the new bus operations and maintenance facility building, the employee parking structure, and the future charging of BEB's onsite. Coordination efforts with Dominion started early during the Design Development Phase and continued throughout the duration of the design and construction.

An initial load letter specifying the required electrical load of the new facility was submitted to Dominion in February 2021. The load letter was later revised in August 2021 to account for the administrative and operations space being transferred from the employee parking structure to the maintenance building.

The new facility was also designed to include two natural gas standby generators. Washington Gas was engaged to provide the necessary amount of natural gas to feed the proposed standby generators. Initially the standby generators were sized without accounting for BEB charging infrastructure. However, after the scope of work changed to include the BEB infrastructure, the Washington Gas load letter was revised around January 2023. The revised load letter accounted for the BEB infrastructure needed to service the BEB's onsite.

Since the new facility was designed and constructed to include PV panel infrastructure, which is an approved renewable energy generation system, Arlington County ultimately entered into a net metering agreement with Dominion to receive credit for the excess energy generated from the PV panels that is fed back into Dominion's electrical grid. Each structure associated with the project was considered for net metering separately. The power demands for the operations and maintenance facility are large so net metering was not a critical consideration. The garage structure requires a relatively small amount of power and has a large PV canopy, so it has potential to generate large amounts of excess power. Initially, Dominion did not want to accept net metering at the garage and requested that the PV area be reduced to accommodate the garage power requirements only. However, Dominion later reversed their decision and accepted net metering for this location. This resulted in changes to the PV configuration during construction. In order to proceed with the 30% design of the PV panel infrastructure for the garage, the County proceeded before meeting with Dominion and finalizing a net metering agreement.

Lessons Learned:

In general, early coordination is critical to the following aspects of a bus operations and maintenance facility project, a project containing BEB charging infrastructure, and/or a project containing PV panel infrastructure:

- Understanding industry trends, political factors and technological advancements that result in scope changes related to BEB transitions. The change in project scope to add the BEB infrastructure, which was initiated by the County Board, required additional coordination to implement the large-scale change by the designer, CMAR, and owner.
- Identifying the required electrical and/or gas load on a proposed building and/or facility is critical. The AMOF Project was originally scoped to account for charging a future 100% BEB fleet. Therefore, when the project scope was modified to include the BEB charging infrastructure now vs. deferring it for a future project, no change in the electrical requirements for the new facility was required.

- It is important to understand the staffing and resource limitations on utility providers. Communicating the project schedule to the utility providers and maintaining that schedule helps avoid delays resulting from postponing planned mobilizations by utility providers.
- It is important to understand staff turnover is very common. Therefore, it is very important to maintain regular contact with utility provider points of contact and document decisions such as roles, responsibilities, and schedules throughout the duration of the project.
- Perform research on any other projects that are either impacting existing infrastructure or causing additional demand and associated timing.

Coordination with Building Code Officials/Fire Marshal

There are very few established building code requirements related to fire protection at BEB facilities, which just highlights the need to engage the local Fire Marshal early in the design process to ensure a mutual understanding of the design intent and accepted practice. Examination and review of the fire and life safety analysis can be an important part of establishing the mutual understanding and shared vision of the design intent with the Fire Marshal and other stakeholders.

The Arlington County Fire Marshal was first engaged during the Schematic Design Phase of the AMOF Project. The Fire Marshal conducted reviews that were based on Arlington County code requirements and standards. As a result of the Fire Marshal's review during the permitting process for the BEB site canopy PV panel design, the PV panels were installed at an inclined angle rather than flat as originally intended. Inclined PV panels can help improve ventilation and reduce reflected heat back onto the supporting structure.

Figure 1 – View of Inclined PV Panels

The Arlington County Fire Marshal also requested that two additional fire hydrants be added at the AMOF site. These additional fire hydrants were not required per code but were installed based on the Fire Marshal's request.

Figure 2 - Added Fire Hydrant in Vicinity of PV Canopy

Lessons Learned:

- Early and regular coordination with the Fire Marshal and local building code officials is critical, especially for BEB facilities where nationally adopted code requirements have not been established.
- Installation of PV panels at an angled orientation has a variety of safety benefits that help to aid ventilation and reduce reflected heat back onto the structure.
- Additional firefighting features such as fire hydrants and standpipes will likely be required to deliver a high volume of water for fire suppression needs as BEB fires require a large amount of water to cool the batteries and prevent a cascading event.

Considerations for the Design of Battery Electric Bus (BEB) Infrastructure

It is critical when initiating BEB infrastructure design to understand the planned site from a holistic point of view. This includes an understanding of the facilities operation, the number and size of BEB's assigned to the facility, the architectural plans of the facility, charging operation requirements (e.g. route modeling and charging analysis). This provides insight as to whether the charging can be utilized as typical overnight (slow charging) or requires mid-day charging (fast charging), or both. It is also extremely imperative to review the electrical utility service requirements for large load customers. Once that is known, the 15% or 30% design plans can be developed. This should be discussed internally with agency stakeholders to ensure all departments (Operations, Maintenance, Safety, etc.) agree on a path forward.

BEB fleet charging infrastructure design is fairly new in the United States, as many agencies are only beginning their zero emission transition plans. This period of transition in Arlington County coincided with the AOMF Project timeline. The County Board added full BEB infrastructure to the scope of the project after preliminary design had already been completed and a CMAR had been

selected. This major addition to the project scope, after the project had already started, led to increased costs due rework and additional coordination.

Aside from the change in scope that added BEB infrastructure to the project, the BEB design process followed an orderly, linear process. The BEB design went through each successive design step from concept, schematic, to detailed design and construction. The project team did not experience any challenges locating a qualified BEB designer or navigating and interpreting the design code. The locality review of the BEB design also did not place any major constraints on the design.

However, one constraint on the design was the EV charging equipment and network provider. Initially the Basis of Design (BOD) was based on upon equipment from a specific provider, however based on additional information gathered and customer feedback, Arlington Transit initiated a change to use equipment from a different provider. This change also resulted in additional rework and coordination. For example, the BOD had to be updated for the new equipment specifications, and those equipment specifications had to be reviewed for compatibility with other aspects of the project design. Choosing the EV charging equipment provider also inherently limits choices in the variety of equipment that can be used. Overall, the best approach would be to select the charging equipment concurrently as other accepts of the project are being developed.

In general, local municipality feedback is adjudicated during the planning phase, with inputs from neighborhood and zoning boards that dictate whether the bus storage and charging operations should be indoors or outdoors. Indoor BEB storage and charging tends to increase the space requirements and hence the facility building becomes much larger. The public also expressed concern over the visual aspect of the project, which led the County to require special consideration for screening and architectural finishes.

Overall, it is critical to develop design criteria for the BEB facility charging operations early during the project development. The intent of which is to capture the transit agency's stakeholder requirements, both technically and operationally. The transit agency should engage a design consultant who has experience developing and designing BEB facilities/criteria and who can present options for the technical and operational control of the facility. This will help advance the design quicker with known specifications and requirements. It is also important to identify and address the specific challenges associated with BEB infrastructure in the fire and life safety analysis. Specifically, the challenges associated with thermal runaway for lithium-ion batteries can have a major impact on the building design. Thermal runaway is a self-sustaining cycle of increasing temperatures which is extremely difficult to manage once initiated.

Lessons Learned:

- The project incurred additional costs due to decision to add the BEB charging infrastructure and PV panel infrastructure to the project scope after design and award of CMAR contract.
- The change in the BEB charging equipment provider resulted in a change to the Basis of Design (BOD).
- There were few options to choose for BEB charging equipment after design was completed. The bus manufacturer should be chosen before the design is complete, so that design and coordination can be done earlier on.
- Start discussion about warranties and service agreements early on with suppliers.

Considerations for CMAR Delivery Method

Construction Manager at Risk (CMAR) is a method of project delivery in which the owner contracts a construction manager during the design phase, who oversees the project from buyout through closeout based on an agreed to Guaranteed Maximum Price (GMP). The owner also maintains a separate contract with the designer; however, the CMAR has input during the design process. This method is increasingly preferred because the CMAR contract shifts much of the risk and responsibility involved in the construction project over to the construction manager or construction management firm, while allowing the owner to maintain significant control over the design. This delivery method is often referred to as "CM/GC" because the construction manager acts as both the construction manager (CM) and general contractor (GC) on the project. Despite the CMAR's acceptance of greater risk and ownership of the project design and construction, it is critical for the owner to develop an Independent Cost Estimate (ICE) for delivery of the project. The ICE provides a valuable check on the accuracy of the GMP established by the CMAR and ensures fair pricing.

Arlington County chose the CMAR delivery method with the expectation that it would expedite the delivery of the project. Arlington County had a successful enticement with ten qualified contractors responding to the Request for Qualifications (RFQ). The evaluation process went smoothly as Arlington County requested best and final offers from five (5) contractors, then invited three (3) contractors for an oral presentation.

The CMAR's responsibilities relating to low bid subcontractor work and questions about plans/specifications were well defined. The CMAR's responsibilities related to raising issues during plan review were also well defined. The clear delineation of roles and responsibilities defined in the GMP contract ensured an open and effective working relationship between Arlington County and the CMAR. In this collaborative environment the CMAR offered many value-added comments throughout the design process, particularly related constructability and material/equipment selection. This is credited as one of the reasons that the project was delivered over one year earlier than what could have been accomplished with a traditional design-bid-build delivery method.

One of the benefits of the CMAR delivery method is that it allows for construction to commence while the design process is ongoing, thereby accelerating the project delivery schedule. For example, the CMAR began preliminary construction activities such as clearing and grubbing, demolition, salvage, abatement, and erosion and sediment control setup soon after finalizing their agreement with Arlington County, as the final design was being advanced on this project.

The cost allowances for power undergrounding, PV and BEB infrastructure were exceeded due to changes in the BEB infrastructure design, permit requirements, and coordination with Dominion throughout the life of the project. These coordination and design issues also negatively impacted the project schedule. Advancing the GMP Plans to a final level of design that included all project components could have alleviated this risk. However, finalizing the design in advance of issuing GMP Plans is inherently difficult using CMAR delivery method, and eliminates part of the benefit gained through the CMAR's participation in the design process. Alternatively, the CMAR delivery method may be better suited to non-BEB projects at this time. Risk can be more easily evaluated in non-BEB projects due to the more established history of design standardization and design/building code clarification. Increased allowance for BEB infrastructure components may also be justified to mitigate risk.

Overall, the CMAR delivery method was viewed as a positive project approach, but early involvement is critical in resolving key issues for similar projects. The clear definition of roles and responsibilities at the onset of the project as well as an engaged, consciences CMAR contributed to the success of this project. The GMP contract associated with the CMAR delivery method may have created additional complications when the BEB scope was changed. Reserving the CMAR delivery method for more traditional projects without emerging technologies, like BEBs, may be ideal. Alternatively, additional risk can be priced into the project for items such as BEB infrastructure by a close investigation of increased allowances. Arlington County has indicated that they are very likely to use the CMAR delivery method on future projects based on the success of the AOMF Project.

Lessons Learned:

- The clear definition of the CMAR's roles and responsibilities is critical. Especially related to the CMAR's responsibility to adhere to the contract GMP.
- Close examination of allowances for high-risk design items is needed, especially when utilizing the CMAR delivery method.
- The CMAR delivery method locks the owner into a GMP. Introducing large scope changes that were not part of the original GMP will require a formal change order to adjust the price and contract terms as the owner is typically responsible for the additional costs resulting from owner-requested changes or design changes that fall outside the initial GMP scope.

Summary

Planning and coordination are major throughlines for all lessons learned on the AOMF Project. The Fire Marshal/building code officials and utility companies are key stakeholders on all projects but especially on BEB projects where design standards are not well established and scope changes can occur. Defining the scope of the project early on, especially when it comes to emerging technologies such as BEB infrastructure is critical. It is also important to select a BEB equipment provider early on in the project so that design can advance in coordination with the equipment that forms the BOD. A clear design intent and BOD will help eliminate rework and additional coordination late the in project.

The CMAR construction delivery method can be an effective and valuable tool to complete projects, provided that all roles and responsibilities are clearly defined. However, the type of project and the inclusion of allowances for unknowns should be considered when selecting the CMAR delivery method. The CMAR delivery method locks the owner into a GMP that could make large changes to the project even more costly.