John W. McCormack Building - Immediate Needs

Switchgear Retrofill Assessment

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Division of Capital Asset Management and Maintenance (DCAMM)

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1. Introduction

In 2017, DCAMM commissioned a Comprehensive Facilities Plan (CFP) study which was developed by Saam Architecture and Jacobs. The goal of the study was to evaluate the building and its systems and identify deficiencies in several areas including code compliance, life safety, accessibility, resiliency, ease of maintenance etc. Ultimately, the CFP recommended that several "critical vulnerabilities" be addressed immediately, while a broader full building renovation including all interior spaces, systems, and building envelope would take place over the next ten years.

The CFP assigned a risk level to the deficiencies that were investigated. Those items that were considered to have the highest likelihood of system failure, greatest severity of consequences of system failure, and greatest risk to building occupant safety were classified as Immediate Needs. In 2018, DCAMM commissioned the Immediate Needs study to evaluate the options available for addressing the Immediate Need items identified in the CFP. One of the items identified as an Immediate Need was replacement of the building main electrical switchgear. As part of the Immediate Needs Study, Jacobs evaluated the existing conditions of the switchgear and options for replacement, and ultimately made a recommendation of to fully replace the building main switchgear using a phased approach. Following certification of the Immediate Needs study by DCAMM, Saam and Jacobs developed construction documents detailing the replacement of the switchgear.

In September 2020, DCAMM Engineering informed Jacobs and Saam that due to several factors that had developed since the certification of the Immediate Needs study, notably the Commonwealth's "net zero" goal with respect to emissions, the expected electrical use in the building was expected to rise in the future in order to offset natural gas use. Concerned that the switchgear design developed in the Immediate Needs construction documents would no longer accommodate the expected future needs of the building, DCAMM Engineering requested that Jacobs assess the possibility of a short term retrofit solution to extend the life of the existing switchgear until the future electrical needs of the building can be better understood.

2. Existing Switchgear Conditions

The existing main switchgear is located on Level G1 adjacent to the G1 mechanical room. The main switchgear is responsible for taking utility power from the Eversource owned utility transformers, located in a vault under the sidewalk on Bowdoin St., and transferring it to the building power distribution system. Ultimately all normal (non-emergency) power that serves the building electrical closets, HVAC equipment, elevators, fire pumps, and other building critical systems reaches those systems through the building main switchgear.

The existing main switchgear is a General Electric model AKD-5, 480Y/277V, 3-Phase, 4-Wire switchgear. It is original to the building, and well beyond its expected service life (typically 20-30 years for well maintained equipment. Notably, the circuit breakers, which are responsible for isolating the downstream electrical equipment and wiring for protection in the event of an overcurrent, short circuit, or fault, have not been tested or maintained since 2008. These circuit breakers are also meant as a point of disconnect allowing power to be turned off for maintenance and testing of downstream equipment.

While the entire switchgear assembly is beyond its service life and should be replaced, there are particular concerns related to the age and condition of the circuit breakers. The existing General Electric Model AKU circuit breakers are complex electromechanical devices. The circuit breakers are the most complex part of the equipment and require regular maintenance, testing, and refurbishment as internal components wear. Due to the advanced age of the circuit breakers, they are no longer directly supported by the manufacturer. The supply chain for repair parts is all aftermarket, unreliable, and at a cost premium. Because of the lack of easily obtainable repair parts, and history of little regular maintenance, building electrical personnel do not have confidence in the ability of the equipment to operate as intended.

At best, the lack of confidence in the circuit breakers ability to perform their functions, prevents their use as a point of disconnect for use in testing and maintenance of downstream systems. This leaves the building maintenance personnel with no choice but engage the utility company for all shutdowns of the main power feeders in the building by performing a disruptive full building shutdown from the utility transformer sidewalk vault. Shutdowns performed in this manner are costly and extremely disruptive to building occupants and systems.

At worst, a malfunctioning circuit breaker could fail to open in the event of a short circuit or overcurrent event. The circuit breaker is designed to disconnect the downstream circuit from a damaging level of current when the threshold that can be tolerated by the downstream equipment and wiring is exceeded. A malfunction would result in catastrophic failure of downstream wiring and equipment, significant downtime of critical systems, and costly repairs.

3. Immediate Needs Switchgear Replacement

The Immediate Needs study evaluated options for replacement of the switchgear as recommended by the CFP, and identified a preferred option for replacement. The approach recommended by the Immediate Needs study was a phased approach to construct new switchgear in the adjacent mechanical room, prior to demolishing all but the incoming service conductor connections of the existing switchgear, and installing new sections interfaced to the incoming service connections to route the utility power to the new switchgear. The end result of this approach would be a brand new, easily maintainable switchgear, with all new components, including state of the art circuit breakers and digital controls with an expected service life of 30 years with regular maintenance.

Due to the critical nature of the switchgear in providing power to all building systems and equipment, the design of the new switchgear accommodates a phased approach in an attempt to minimize disruption to the building occupants and systems. Work required to make temporary power connections and cutover systems from the existing switchgear to new, must be performed with the equipment de-energized, which requires full shutdowns of the building. Based on requirements given by DCAMM Engineering and DCAMM Facilities departments, the design team included extensive phasing requirements in the Immediate Needs construction documents, to limit the number of full building shutdowns. Based on the scope of work required, it was determined by the design team that four full building shutdowns and 3 partial building shutdowns would be required to install the new equipment, make connections, and remove the existing equipment.

It is important to note that at the time that the Immediate Needs study was performed and certified, feedback given to the design team by DCAMM did not indicate that the building electrical loads would be likely to significantly increase. Given that information, the replacement switchgear that was designed is equivalent in electrical capacity to the existing switchgear, and cannot be expanded as designed to accommodate additional electrical capacity. A number of factors limit the capacity of the switchgear as designed including the space allotted for the new equipment, commonly available equipment in similar configuration, and the capacity of the existing-to-be-reused service conductors.

As previously discussed, DCAMM Engineering has since expressed concerns that with the evolving needs of the building since the Immediate Needs study, notably the net zero emissions goals, significant additional electrical capacity is likely to be required in the near future of the building. It is the opinion of the design team that the new switchgear, if installed as designed will not be able to accommodate the predicted future increase in electrical loads. It is also the opinion of the design team that given the recently evolving needs of the building, extensive planning effort is required to determine the future electrical loads prior to determining the capacity required and scope of electrical system improvements needed to meet future demand.

Pros:

-Entire switchgear assembly is new, including microprocessor trip, remotely operable circuit breakers, enclosure, bus, and ancillary components

-Entire switchgear assembly will be factory tested prior to shipment

-Full manufacturers warranty for entire switchgear

-Preventative maintenance IR viewing windows for on-site bus distribution assessment while energized.

Cons:

-Electrical capacity of new switchgear as designed may not be sufficient for future building needs

-Requires (4) full building shutdowns, (3) partial building shutdowns due to phasing requirements

-Lead times on new switchgear currently as long as 44 weeks, extends time relying on old circuit breakers

Anticipated Construction Cost (Based on Trade Contractor SOV): $2,564,200

4. Proposed Alternate: Circuit Breaker Retrofill

As an alternate approach to a full replacement of the switchgear, DCAMM Engineering asked the design team to assess the possibility of replacing only the circuit breakers and retaining the existing switchgear bussing and enclosure, a process known as a retro fill. Replacement of the circuit breakers with new, current technology, will restore the switchgear to a better operating condition and allow a short-term extension of the useful life of the switchgear. This will allow planning efforts to better determine the future electrical needs of the building and accurately define the requirements for replacement of the switchgear.

At the request of DCAMM Engineering, the switchgear and circuit breaker manufacturer ABB, visited the McCormack building to determine the required scope of work to retrofit the existing switchgear with new circuit breakers. ABB was chosen to perform an initial evaluation because they are the owner and manufacturer of the legacy General Electric low-voltage switchgear product line. Given their ownership of the GE product line, including factory drawings of the existing GE AKD-5 switchgear at the McCormack building, ABB has the capability of manufacturing direct -fit replacement circuit breaker assemblies utilizing current technology, that interface cleanly with the existing switchgear.

The process to retro fill the existing switchgear would include an initial full building shutdown during which the manufacturer confirms all required dimensions and other pertinent information needed to manufacturer the new circuit breaker assemblies, and performs infrared testing to verify the integrity of the existing bussing that will remain. This shutdown mitigates the risk of any problems being discovered during the future shutdown for circuit breaker installation. After the initial shutdown, the manufacturer will design the new circuit breaker assemblies in approximately 2 to 4 weeks, and then after shop drawing approval, manufacturer the new circuit breakers and deliver them on site and ready for installation in approximately 16 to 18 weeks. The installation process requires another full building shutdown, and can be completed, with operational testing of all circuit breakers, within as little as 24 hours.

After the circuit breaker retro fill process is complete, the existing switchgear will be outfitted fully with new, current technology circuit breakers. The circuit breakers will be a manufacturer's standard product, fully serviceable and supported by the manufacturer with technical support and replacement parts as needed for the forseeable future. In the short term, this will allow the electrical maintenance staff to better maintain and test the switchgear and downstream electrical systems, and will allow better isolation and protection of individual systems in the event of a fault in the electrical system. In the long term, this will buy the necessary time for the planning effort needed to determine the capacity and configuration required for the new switchgear, and allow greater flexibility in phasing the future switchgear replacement.

Pros:

-Restores operating condition of circuit breakers by replacing with modern, warrantied units

-Only requires (2) shutdowns

-Installation complete within 22 weeks of purchase

-Allows planning of appropriately sized replacement switchgear while mitigating immediate risk of non-maintainable, possibly non-operational circuit breakers

Cons:

-Remaining switchgear components (bussing, enclosure, etc.) remain in place and in excess of 30 year max. service life

-Up front additional cost to replace circuit breakers now is lost when switchgear is replaced in 3 to 5 years

Order of Magnitude Cost: $820,000 +/- 15%

5. Recommendation

Given the stated need to further examine future electrical demands of the building, the significant disruptions required to the building, and the long lead times and construction schedule required, Jacobs does not recommend replacement of the switchgear at this time, utilizing the Immediate Needs switchgear design. Instead, Jacobs recommends moving forward with a retro fill of the existing switchgear with new circuit breakers to extend the switchgear life. This will allow an informed planning and design process to account for expected future demand load increases, while mitigating the risks and operational difficulties posed by the existing switchgear circuit breakers.