BEFORE THE
PUBLIC SERVICE COMMISSION
STATE OF NEW YORK

Application of New York Power Authority for a Certificate of Environmental Compatibility and Public Need for the Rebuild of the Existing Moses-Adirondack 1&2 230 kV Transmission Lines Extending approximately 86 miles from the Robert Moses Switchyard in the Town of Massena, St. Lawrence County to the Adirondack Substation in the Town of Croghan, Lewis County, New York.	Case No.: 18-T-XXXX

NEW YORK POWER AUTHORITY

MOSES-ADIRONDACK SMART PATH RELIABILITY PROJECT

EXHIBIT E-1

DESCRIPTION OF PROPOSED TRANSMISSION LINE

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E-1. EXHIBIT E-1: DESCRIPTION OF PROPOSED TRANSMISSION LINE

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line. Such description shall include: (a) the design voltage and voltage of initial operation; (b) the type, size, number, and materials of conductors; (c) insulator design; (d) the length of the transmission line; (e) the construction materials of the towers; and (f) the design standards for each type of tower and tower foundation.

E-1.1. Introduction

The Power Authority of the State of New York, doing business as New York Power Authority ("NYPA" or the "Applicant"), proposes to rebuild the existing 230 kilovolt ("kV") Moses-Adirondack 1 & 2 transmission lines ("MA1&2"), which extend approximately 86 miles between the St. Lawrence Power Project's Robert Moses Power Dam Switchyard ("Moses Switchyard") in the Town of Massena, St. Lawrence County, New York ("NY") and the Adirondack Substation in the Town of Croghan, Lewis County, NY (the "Project"). The MA1&2 transmission lines were built in 1942 and transferred to NYPA in 1950. Since that transfer, the MA1&2 lines have at all times been owned, operated, and maintained by NYPA. The MA1&2 lines consist of approximately eight (8) miles of double-circuit lattice structures and approximately seventy-eight (78) miles of single-circuit predominantly wood H-frame structures. The Project proposes to rebuild the MA1&2 lines as two single-circuit 345 kV lines on steel monopoles, operated initially at 230 kV. In addition, the Project includes the future construction of new 345 kV switchyards at the existing Moses Switchyard and at the Adirondack Substation. With the exception of an approximate one-mile reroute of the Project at the State University of New York at Canton ("SUNY Canton") campus, the Project would be constructed entirely within an existing right-of-way ("ROW") maintained by NYPA. NYPA will construct the Project in two

phases. The first phase of the Project, Phase One, will involve rebuilding the existing approximately 78-mile single-circuit predominantly wood pole portion of the line with single-circuit steel monopoles. Phase Two of the Project will involve rebuilding the existing eight-mile double-circuit steel lattice with single-circuit steel monopoles, rebuilding 0.4 miles of single-circuit steel lattice structures into Adirondack Substation with single-circuit steel monopoles, and constructing the new 345 kV switchyards at the Moses Switchyard and the Adirondack Substation.

E-1.2. Description of the Proposed MA1&2 Lines

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line.

The existing MA1&2 lines are constructed on steel double-circuit lattice towers for the first approximately eight (8) miles, originating at the Moses Switchyard. The lines are constructed on two single-circuit predominantly wood pole structure lines for the remaining approximately 78 miles to Adirondack Substation, with the exceptions being single-circuit lattice towers at transmission line crossings at ROW mile marker 43.3 and ROW mile marker 85.1 and a long span valley crossing at ROW mile marker 85.3. The Project proposes to rebuild the existing MA1&2 230 kV transmission lines with two single-circuit steel monopole lines, constructed for 345 kV operation, and initially operated at 230kV.

From ROW mile marker 0.0 (at the Moses Switchyard) to ROW mile marker 8.0, the proposed MA1 line replacement will be constructed on or very close to the existing MA1&2 lattice tower centerline. The MA2 line will be laterally offset approximately 100 feet from the proposed MA1

centerline. Span lengths will be similar to that of the existing towers in this segment with approximately 1,000-foot spans on average.

From ROW mile marker 8.0 to ROW mile marker 35.6, the proposed transmission lines will be installed within the existing 250-foot ROW. The new transmission line centerlines will typically be located within approximately five (5) feet of the respective existing MA1&2 centerlines. Span lengths in this segment will be approximately 1,100 feet on average.

From ROW mile marker 35.6 to ROW mile marker 36.7, the MA1&2 transmission lines will be located in a new 250-foot ROW generally along the periphery of the SUNY Canton campus. The lines will be spaced approximately 100 feet apart, with each line's centerline approximately 50 feet from the center of the ROW. Span lengths in this segment will be approximately 1,200 feet on average.

From ROW mile marker 36.7 to ROW mile marker 85.7 (at the Adirondack Substation), the proposed transmission lines will be installed within the existing 250-foot ROW. The new transmission line centerlines will typically be located within approximately five (5) feet of the respective existing MA1&2 centerlines. Span lengths in this segment will be approximately 1,050 feet on average.

The Project will remove approximately 1,625 structures and replace them with approximately 860 structures. The structures will be a single-circuit monopole design, ranging from approximately 105 feet to approximately 175 feet in height, except as follows. Twenty (20) specialized low height single-circuit H-frame structures ranging from approximately 55 feet to approximately 85 feet in height will be used at the five locations where the MA1&2 lines cross

beneath the Massena-Marcy 765 kV ("MSU-1") electric transmission line. Structures at the crossing of the existing National Grid Browns Falls–Taylorville 115 kV line in Croghan will be approximately 180 feet in height for the necessary clearance. Structures at the crossing of the St. Lawrence Seaway will be approximately 195 feet in height, and structures at the crossing of the Wiley-Dondero Canal will be approximately 255 feet in height. These heights are similar to the existing MA1&2 tower heights at these water crossings to maintain the existing clearances over the water at the maximum conductor sag condition.

E-1.3. Design Voltage and Voltage of Initial Operation *(16 NYCRR § 88.1(a))*

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line. Such description shall include: (a) the design voltage and voltage of initial operation;

The transmission lines will be designed and constructed to operate at a nominal voltage of 345 kV, phase to phase, alternating current ("AC"). The initial operating voltage will be 230 kV. The switchyard and substation upgrades proposed at Moses Switchyard and Adirondack Substation will be designed and operated at a nominal voltage of 345 kV, phase to phase.

E-1.4. Conductor Design *(16 NYCRR § 88.1(b))*

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line. Such description shall include: (b) the type, size, number, and materials of conductors;

The proposed transmission line conductors will be two 795 kcmil 26/7 (26 aluminum strands surrounding 7 steel core strands) "Drake" ACSR (aluminum conductor, steel reinforced) per phase conductor, arranged in a horizontal bundle, with the subconductors spaced at the industry standard 18 inches. "Drake" ACSR conductor has a cable outside diameter of approximately

1.107 inches and rated breaking strength of 31,500 lbs. The Project will specify a "non-specular" finish for the conductor to reduce reflectivity.

The phase conductors will be arranged in a delta configuration (two phases on one side of the structure and one phase on the opposite side of the structure at a height midway between the other two phases). At select locations, the phases will be brought to a horizontal configuration. This occurs at the five (5) locations where the proposed transmission line crosses below the MSU-1 line and at the Moses Switchyard and Adirondack Substation terminal locations.

The two shield wires (i.e. overhead ground wires), which are located at the top of the transmission lines above the phase conductors, will be composite optical ground wire ("OPGW") with an outside cable diameter of approximately 0.726 inches. The OPGW cables will consist of 13 aluminum-clad steel strands surrounding an aluminum tube containing 48 single-mode optical fibers.

Aeolian vibration of the conductors will be controlled by use of suspended mass dampers mounted on the conductors near the structure support points. Aeolian vibration of the OPGW shield wires will be controlled by use of spiral vibration dampers mounted on the OPGW shield wires near the structure support points.

E-1.5. Insulator Design *(16 NYCRR § 88.1(c))*

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line. Such description shall include: (c) insulator design;

The insulators for the Project will be suspension-type with ball-and-socket integral fittings. The insulator sheds will be made of toughened glass and will be transparent (with a slight blue-green tint). The insulator caps and associated hardware will be made of galvanized forged steel. Suspension applications will use single-string assemblies with 18 insulator units per string. Double-string suspension assemblies will be used for any suspension applications located at highway, railroad, and water crossings. Strain applications (i.e. dead-ends) will use double-string assemblies with 20 insulator units per string.

Table E-1-1: Insulator Characteristics

NEMA Class:	52-5-H	52-8-H
Insulator Material:	Toughened Glass	Toughened Glass
Shed Profile:	Standard	Standard
Connection Type:	Ball & Socket, Type J	Ball & Socket, Type K
M&E Strength:	30,000 lbs.	40,000 lbs.
Proof Test Load:	15,000 lbs.	20,000 lbs.
Shed Color:	Transparent	Transparent

E-1.6. Length of the Transmission Line *(16 NYCRR § 88.1(d))*

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line. Such description shall include: (d) the length of the transmission line;

The Project will be approximately 86 miles in length.

E-1.7. Construction Materials of the Towers *(16 NYCRR § 88.1(e))*

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line. Such description shall include: (e) the construction materials of the towers;

The Project's towers will consist of tubular self-supporting steel structures with a hot dip galvanized surface coating.

E-1.8. Design Standards for Towers and Tower Foundations *(16 NYCRR § 88.1(f))*

16 NYCRR § 88.1: The applicant shall submit a detailed description of the proposed transmission line. Such description shall include: (f) the design standards for each type of tower and tower foundation.

E-1.8.1. Design Standards for Towers

Drawings of the proposed tower types are provided in Exhibit 5: Design Drawings, Figure 5-1 to Figure 5-7. The proposed towers are single-circuit steel monopole structures with davit arms supporting the conductors and shield wires. As described in Section E-1.2, single-circuit steel H-frame structures of steel tubular construction will be installed at locations where the MA1&2 lines cross beneath the MSU-1 line. Structure pole shafts will be 12- or 16-sided sections that will slip fit or bolted together in the field. Slip fit pole sections, where utilized, will be mated and jacked together. Structures will be designed and fabricated in accordance with the relevant codes and standards as listed in Section E-1.8.5.

Structure loads for design of the towers will be developed in compliance with the NESC, latest edition. as well as other more stringent criteria per NYPA Overhead Transmission Standard O-

TRA-STD-201-R00 (provided in Appendix A). The minimum structure design loads will include the following loading cases:

- NESC Heavy Loading: ½-inch radial ice at 0° F, with a 40 mph wind, with overload factors applied
- NESC Extreme Wind: 90 mph wind at 60° F
- NYPA Heavy Ice: 1 ½ inch radial ice at 30° F, with overload factors applied
- NYPA Ice & Wind: 1 inch radial ice at 30° F, with a 50 mph wind, with overload factors applied

E-1.8.2. Design Standards for Tower Foundations

The Project's proposed foundations for the towers will include:

- Drilled Shaft Foundations
- Direct Embedded Pole Foundations
- Micropile Foundations
- Rock Anchor Foundations

Tangent structures will utilize direct embedded pole foundations where soil conditions and magnitude of loading allow. Concrete drilled shaft foundations (also commonly referred to as "drilled piers" or "caissons") will be used for all structures other than tangent structures and may also be used at select tangent structure locations where direct embedded pole foundations are not feasible. In areas of shallow bedrock (within approximately 15 feet of ground surface) micropile foundations or rock anchor foundations may be utilized. In areas with very soft subsurface soil

conditions, micropile foundations may be utilized. The application of these two foundation types as an alternative to drilled shafts or direct embedded poles will be determined in final design.

E-1.8.2.1. Drilled Shaft Foundations

Drilled Shaft Foundations will consist of a steel reinforcing cage and steel anchor bolt cluster placed into a drilled excavation and filled with concrete. The above grade portion of the foundations will extend approximately 1 to 2 feet above ground level and will be formed in a cylindrical shape about 2 to 3 feet in diameter larger than the base diameter of the steel pole. Drilled Shaft Foundations will be designed in accordance with ACI 318 - 14, Building Code Requirements for Structural Concrete. Typical Drilled Shaft Foundation details are provided in Exhibit 5: Design Drawings, Figure 5-8.

E-1.8.2.2. Direct Embedded Pole Foundations

Direct Embedded Pole Foundations will consist of a pole base section set into a drilled excavation and backfilled around the pole with crushed stone. In cases of water filled excavation or when overall excavation depth does not allow for proper compaction of the crushed stone, concrete will be utilized for backfill around the pole as an alternative to crushed stone. The base section of the monopole in a direct embedded pole foundation will have a ground sleeve, an additional steel wall fabricated to the outer pole shaft surface in the region of the ground line interface. The ground sleeve provides added protection against corrosion. Additionally, a dielectric urethane coating, gray in color on exposed surfaces, will be applied during manufacturing for additional corrosion protection for the embedded region of the pole. Typical

Direct Embedded Pole Foundation details are provided in Exhibit 5: Design Drawings, Figure 5-9.

E-1.8.2.3. Micropile Foundations

Micropile Foundations will consist of cementitious grout-filled steel casings (typically in the range of 7 to 12 inches in diameter) with steel tension rods and top bearing plates to make up the individual micropiles. A steel reinforcing cage and steel anchor bolt cluster will be placed in the poured concrete cap. Micropile Foundations will be designed in accordance with ACI 318 - 14, Building Code Requirements for Structural Concrete. Typical Micropile Foundation details are provided in Exhibit 5: Design Drawings, Figure 5-10.

E-1.8.2.4. Rock Anchor Foundations

Rock Anchor Foundations will consist of a shallow depth reinforced concrete cap, of which the concrete is poured directly on the exposed bedrock. After the concrete cap has sufficiently cured, holes are drilled through the cap, into the bedrock. Steel anchor rods are grouted or epoxied into the rock and subsequently tensioned. The steel anchor rods will extend up approximately one foot above the top of the foundation concrete. Rock Anchor Foundations will be designed in accordance with ACI 318 - 14, Building Code Requirements for Structural Concrete. Typical Rock Anchor Foundation details are provided in Exhibit 5: Design Drawings, Figure 5-11.

E-1.8.3. Grounding Systems

Structure grounding materials and details will be determined during final design and based upon results of field investigation of ground resistances and consideration of site conditions.

Grounding systems external to the structure foundations will be selected upon final results of the geotechnical investigation. The external grounding systems may consist of ground rods, ground wells, localized buried wire grounding systems (i.e. “counterpoise”) or any combination thereof. All structures, anchor bolt assemblies, rebar cages, and permanent exterior steel foundation casing (where used) will be bonded together and to the external grounding system. The footing resistance at each structure will be verified during construction to meet the required footing resistance values in accordance with a qualified lightning performance study to be completed during the EM&CP development. To the extent possible, grounding conductors will be made inaccessible to avoid potential vandalism or theft of grounding materials.

E-1.8.4. Obstruction Marking and Lighting

NYPA will file a Notice of Proposed Construction or Alteration Application with the Federal Aviation Administration (“FAA”) for all proposed transmission structures and spans that meet the notice criteria per CFR Title 14 Part 77.9. NYPA will adhere to the marking and lighting requirements of the resulting obstruction evaluation determinations expected to be issued by the FAA. Obstruction marking and lighting for the proposed transmission line, where warranted, may consist of:

- Nighttime red flashing lights at top and mid-level of structures.
- Daytime white strobe lights at top level of structures only.
- Spherical markers, 36-inch diameter, mounted onto the shield wires in an alternating sequence of orange, yellow, and white solid color markers.

- Lighted spherical markers, 36-inch diameter, mounted onto the top phase conductors in an alternating sequence of orange, yellow, and white solid color markers, with two steady illuminated red lights per marker.

Structures and wires that are 200 feet or higher may require obstruction marking and lighting. The structures and wires at the crossing of the St. Lawrence Seaway in Massena and at the crossing of the Wiley-Dondero Canal in Massena fall into this category. For air navigation safety of helicopter patrols of power lines, NYPA proposes to install spherical markers on the OPGW shield wires at approximately six (6) crossings of the MA1&2 lines over existing overhead transmission lines.

E-1.8.5. Codes and Standards for Structure and Foundation Design

The proposed transmission line structures and structure foundations will be designed in accordance with all applicable federal, state, and local codes and in accordance with applicable NYPA design standards provided in Appendix A and Appendix B. (These Appendices are currently noted as "draft" because the standards are undergoing NYPA review. The standards will be finalized in the near future and used by Burns & McDonnell during final design of the Project.)

Codes and standards that will apply to the overhead lines, towers, and foundation designs include the following:

- ACI 318 - 14, Building Code Requirements for Structural Concrete
- AISC Steel Construction Manual, 14th Ed.

- ANSI/NEMA C29.2B - 2013, American National Standard for Insulators - Wet Process Porcelain and Toughened Glass - Transmission Suspension Type
- ASCE/SEI Standard 48 - 11, Design of Steel Transmission Pole Structures
- ASCE Manual 74 - 2010, Guidelines for Electrical Transmission Lines Structural Loads, 3rd Ed.
- ASTM A123/A123M - 15, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- AWS D1.1/D1.1M - 2015, Structural Welding Code - Steel
- FAA Advisory Circular 70/7460-1L – Obstruction Lighting and Marking
- IEEE C2 - 2012, National Electrical Safety Code (NESC)
- IEEE 1243 - 1997, Guide for Improving the Lightning Performance of Transmission Lines
- NYPA Overhead Transmission Standard O-TRA-STD-201-R00 – Load Criteria for Transmission Line Structures (Appendix A)
- NYPA Overhead Transmission Standard O-TRA-STD-203-R00 – Criteria for Analyzing Conductor Clearances (Appendix B)