2 PROJECT NEED

2.1 Introduction

The NEP transmission system is an integral part of the regional power system, transmitting electricity to support regional electricity markets and delivering electricity to customers throughout New England. The need for the Project stems from NEP's fundamental obligation as an electric company to provide safe and reliable transmission service to residential, commercial, and industrial customers throughout its service territory. In addition, maintaining system reliability is critical to support recent local, state and federal climate change and electrification policies that are aimed at addressing the adverse effects of climate change and eliminating reliance on fossil fuels by increasing the use of electric vehicles and electric heating applications.

To maintain the integrity of this system, NEP must ensure that adequate and reliable transmission capacity is available to meet existing and projected load requirements and that a secure and reliable telecommunications network is in place to strengthen the security and resilience of critical infrastructure. The grid is designed to meet reliability standards and criteria developed by the North American Electric Reliability Corporation ("NERC"), which sets the minimum standards for electric power transmission for all North America, the Northeast Power Coordinating Council, Inc. ("NPCC") and the Independent System Operator-New England ("ISO-NE").

Accordingly, to ensure that its transmission assets are and will remain in condition to meet these objectives, the Company evaluates the reliability and condition of its assets to determine whether they should be replaced before their performance negatively impacts the provision of safe and reliable service. The need for the Project is consistent with the Company's proactive approach to ensuring the continued reliability of its transmission system.

A review of the recent operating history, design, and physical condition of the Existing Lines and Taps demonstrates that they should be rebuilt to ensure reliable service. As discussed below, the Existing Lines and Taps have inherent design characteristics that compromise the Company's ability to provide reliable service. Those characteristics, as well as physical deterioration on many of the century-old structures, have resulted in poor reliability performance. In addition, the Project is needed to provide increased fiber optic capability to both protect the lines from lightning and improve telecommunications.

To address these concerns, NEP proposes to replace the Existing Lines and Taps within their existing ROWs. Replacing these degraded assets will increase the reliability of the transmission system. The Project also includes installation of two new OPGWs, one for each line, which will better protect the wires from fault-causing lightning strikes and provide an upgraded communications path that will allow for fault detection and high-speed communication between the remote ends of the Rebuilt Lines. The Rebuilt Lines and Taps will be designed with additional capacity to meet known and anticipated future requirements, including the interconnection of new DER, and increasing transfers of power over time to support electrification within the Commonwealth. As further discussed in *Section 3*, the Rebuilt Lines and Taps will initially be operated at 69 kV but will be designed to allow for future operation at 115 kV as it becomes necessary in the future.

Section 2.2 describes the Existing Lines and Taps and their role in the regional transmission system. *Section 2.3* discusses the operating history and current condition of the Existing Lines and Taps. *Section 2.4* describes the need for increased fiber optic capability and *Sections 2.5* and *2.6* discuss the potential for additional capacity and voltage support as well as long-term needs for additional transmission capacity across New England to support state climate and renewable energy policies. Finally, *Section 2.7* summarizes the need for the proposed Project.

2.2 Description of the Existing Transmission System

2.2.1 Existing Lines, Tap Lines and Substations

NEP owns and operates the Existing Lines, which are part of the interconnected New England transmission system carrying network power flows and supplying distribution load-serving substations in western and central Massachusetts. The lines also connect DER resources in central and western Massachusetts and hydrogeneration facilities on the Deerfield River to the transmission system. The Existing Lines were constructed and put into service in the early 1900s. They are approximately 67 miles in length and operate at 69 kV.

The Existing Lines connect NEP's Millbury Substation in Millbury and Deerfield #4 Substation in Shelburne and also supply power to NEP's Pondville, Leicester, Meadow Street, Lashaway, Ware, Belchertown, and Shutesbury Substations. Today, the Existing Lines and Taps provide electricity to 26 cities and towns in MECo's service territory and transmit power from the Harrington, Deerfield #2, Deerfield #3, and Deerfield #4 generating stations to the New England region.

The Existing Lines and Taps are supported by approximately 711 structures centered within the existing ROWs. The existing structures consist of 538 double-circuit steel lattice towers, 75 steel monopole structures, and 98 wood pole structures, about 45 to 80 feet above ground. The existing transmission conductor is primarily ACSR[2]. Representative cross-sections of the Existing Lines and Taps are provided in Appendix 5-3.

From east to west, the substations and taps along the route of the Existing Lines are as follows:

- **Millbury #305 Substation**: NEP's Millbury Substation #305 in Millbury is a transmission and distribution switching station. The E5/F6 Lines extend approximately 4.2 miles along the ROW from Millbury Substation to the Pondville #26 Substation Tap.
- **Pondville #26 Tap and Substation**: The Pondville Substation Taps extend from the E5/F6 ROW approximately 0.01 miles to NEP's Pondville Substation #26 in Auburn, which serves MECo customers in Auburn, Bolton, Leicester, Millbury, Oxford, and Worcester. The E5/F6 Lines continue from the Pondville Tap approximately 5 miles along the ROW to the Leicester #21 Substation Tap.
- **Leicester #21 Tap and Substation**: The Leicester Substation Taps extend from the E5/F6 ROW approximately 0.01 miles to NEP's Leicester #21 Substation in Leicester, which

[2] The Deerfield #3 taps are copper conductor.

serves MECo customers in Leicester, Charlton, and Spencer. The E5/F6 Lines continue approximately 5.6 miles along the ROW from the tap to Meadow Street #552 Substation.

- **Meadow Street #552 Substation:** NEP's Meadow Street #552 Substation serves MECo customers in Spencer, Brookfield, Charlton, East Brookfield, Leicester, North Brookfield, Paxton, and Sturbridge. The E5/F6 Lines continue approximately 1.4 miles along the ROW from Meadow Street #552 Substation to Harrington #2234 Substation.
- **Harrington #2234 Tap and Generating Station:** NEP's Harrington #2234 Station in East Brookfield receives power from the Vuelta solar facility. The E5/F6 Lines extend approximately 2.1 miles along the ROW from the tap to the Lashaway #525 Substation Tap.
- **Lashaway #525 Tap and Substation:** The Lashaway Substation Taps extend from the E5/F6 ROW approximately 0.01 miles to NEP's Lashaway #525 Substation in North Brookfield, which serves MECo customers in Brookfield, East Brookfield, New Braintree, North Brookfield, Warren, and West Brookfield. The E5/F6 Lines continue approximately 7.3 miles along the ROW from the tap to Ware #1 Substation.
- **Ware #1 Substation**: NEP's Ware #1 Substation serves MECo customers in Ware, Barre, East Brookfield, Hardwick, New Braintree, Warren, and West Brookfield. The E5/F6 Lines continue approximately 7.5 miles along the ROW from Ware #1 Substation to the Quabbin Switching Tap.
- **Quabbin Switching Tap and Tower:** The Quabbin Switching Tap extends from the E5/F6 ROW approximately 0.1 miles to NEP's Quabbin Switching Tower in Belchertown, where the E5/F6 Lines connect to NEP's 69 kV B69 line[3]. The E5/F6 Line continues approximately 11.8 miles along the ROW from the Quabbin Tap to Shutesbury #704 Substation.
- **Shutesbury #704 Tap and Substation**: The Shutesbury Taps extend from the E5/F6 ROW approximately 0.02 miles to NEP's Shutesbury #704 Substation in Shutesbury, which serves MECo customers in Shutesbury, Leverett, New Salem, and Pelham. The E5/F6 Line extends approximately 17.2 miles along the ROW from Shutesbury Substation to Deerfield #2 Substation.
- **Deerfield #2 Generating Station:** The E5/F6 Lines extend approximately 2.2 miles along the ROW from Deerfield #2 to the Deerfield #3 Taps.
- **Deerfield #3 Taps and Generating Station:** The Deerfield #3 Taps extend from the E5/F6 ROW in Shelburne approximately 0.5 miles to the Deerfield #3 Generating Station in Buckland. The E5/F6 Lines extend approximately 1.8 miles along the ROW to their termination at Deerfield #4.

[3] The B69 Line, which is about two miles long and feeds Belchertown #509 Substation, is not a part of the Project

- **Deerfield #4 Substation and Generating Station:** Deerfield #4 interconnects several transmission lines, serves Western Massachusetts Electric Company customers and connects the Deerfield #4 generating station to NEP's electric transmission system.

The Existing Lines are the only transmission supplies to the Pondville, Leicester, Meadow Street, Lashaway, Belchertown, and Shutesbury Substations. In addition, the E5/F6 Lines are the only lines transmitting power from the Deerfield #2, #3 generating stations, as well as the Vuelta solar facility, which is connected to the Harrington Switching Station.

- All substations are directly adjacent to the E5/F6 Lines, except Deerfield #3 and Belchertown #509. The Deerfield #3 Taps, which are between Deerfield #2 and Deerfield #4 Substation, are each about 0.5 miles long.

Figure 2-1 shows the location of the Existing Lines, substations and tap lines. A one-line diagram of the existing transmission system is provided as Figure 2-2.

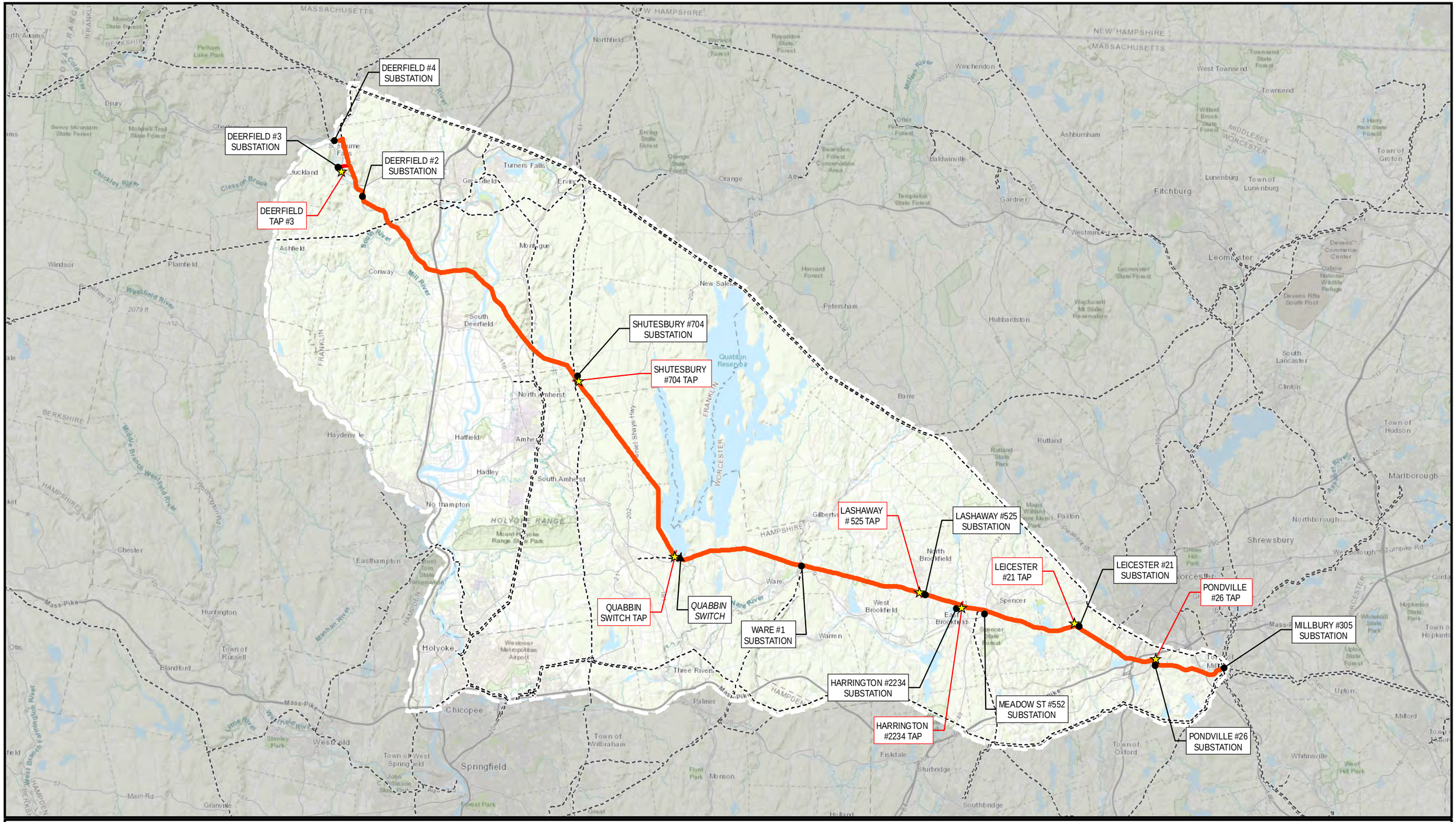

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Figure 2-1

Existing Lines and Interconnected Switchgear, Substations and Tap Lines

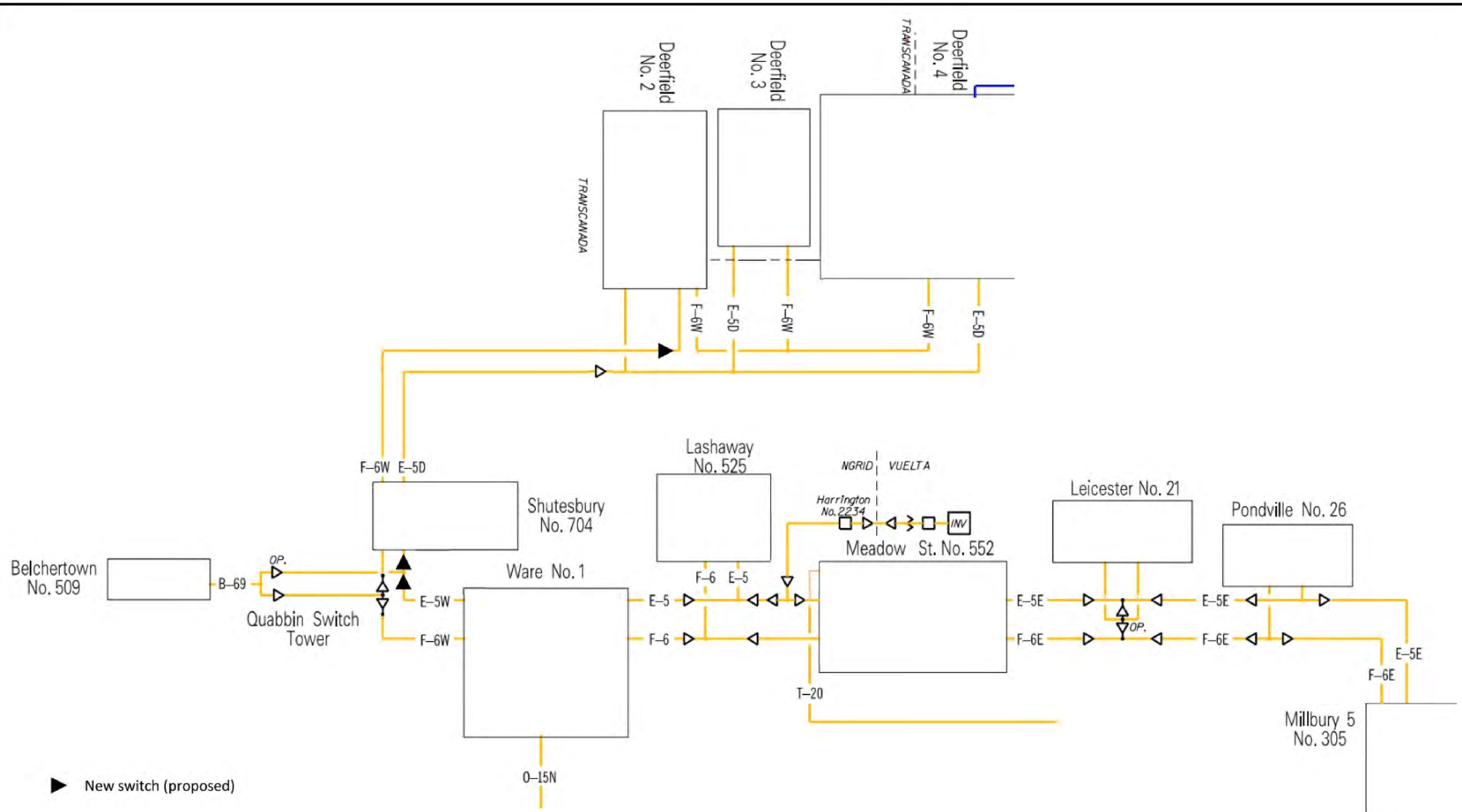

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Figure 2-2
One-line Diagram of the Existing Transmission System

2.2.2 Summer Peak Load

As shown in Table 2-1, approximately 33,000 electric customer accounts in 26 Massachusetts cities and towns are served from substations connected to the Existing Lines. The 2023 summer peak load for the substations served from the Existing Lines is approximately 126.17 megawatts ("MW").

Table 2-1: 2023 Summer Peak Load served by NEP from Existing E5/F6 Lines

Substation	Customers	Load (MW)	Towns Served
Pondville	5,366	8.58	Auburn, Bolton, Leicester, Millbury, Oxford, Worcester
Leicester	4,227	7.53	Leicester, Charlton, Spencer
Meadow Street	6,726	10.17	Spencer, Brookfield, Charlton, East Brookfield, Leicester, North Brookfield, Paxton, Sturbridge
Lashaway	5,038	9.99	Brookfield, East Brookfield, New Braintree, North Brookfield, Warren, West Brookfield
Ware	5,563	10.98	Ware, Barre, Hardwick, New Braintree, North Brookfield, Warren, West Brookfield
Belchertown	5,457	8.71	Belchertown, Amherst, Granby, Ware
Shutesbury	698	4.56	Shutesbury, Leverett, New Salem, Pelham

2.3 Operating History, Design Issues and Condition of Existing Lines

Recent analyses and studies demonstrate that the Existing Lines must be rebuilt to provide better shielding to reduce lightning and weather caused outages and to ensure the safe, efficient and reliable operation of the electric network. Specifically:

- The Existing Lines have a history of poor performance related to the age, condition and design of its structures. In the past six years, the Exiting Lines have experienced 70 outages.
- Poor shielding angles when compared to industry standards and close, tall trees along the ROW likely contribute to the poor performance of the Existing Lines.
- The structures on the Existing Lines have widespread damage, which poses a threat to the reliability of the transmission system.

2.3.1 Operating History

The Existing Lines have been among the least reliable lines on the NEP transmission system, consistently experiencing an unusually high rate of outages. Table 2-2 summarizes the outage history for the E5 Line for the last six years, 2019-2024. Table 2-3 provides the same information for the F6 Line. These issues persist today.

Table 2-2: E5 Line Outage History, 2019-2024

Circuit	Outage Date	Outage Duration (minutes)	Cause	Weather
E5D	2/25/2019	2683	Broken Tree Limb	Fair/Severe wind
E5E	6/30/2019	1	Lightning	Thunderstorms
E5E	7/6/2019	<1	Lightning	Thunderstorms
E5W	7/17/2019	<1	Lightning	Thunderstorms
E5E	7/31/2019	<1	Lightning	Thunderstorms
E5E	8/12/2019	<1	Unknown	Fair/Calm to light wind
E5E	8/18/2019	661	Broken Insulator	Fair/Mild wind
E5W	8/19/2019	<1	Lightning	Thunderstorms
E5D	10/31/2019	<1	Broken Tree Limb	Light rain/Strong wind
E5D	2/13/2020	560	Tree Fell	Freezing rain/Light wind
E5	6/29/2020	<1	Lightning	Thunderstorms
E5W	7/22/2020	<1	Lightning	Thunderstorms
E5D	7/28/2020	<1	Lightning	Thunderstorms
E5E	8/23/2020	<1	Lightning	Thunderstorms
E5	8/23/2020	<1	Lightning	Thunderstorms
E5	8/23/2020	<1	Lightning	Thunderstorms
E5E	10/7/2020	<1	Tree Fell	Light rain/Severe wind
E5D	3/1/2021	<1	Weather, Wind	Fair/Strong wind
E5E	3/1/2021	<1	Tree Fell	Fair/Strong wind
E5E	3/1/2021	<1	Tree Fell	Fair/Strong wind
E5D	3/12/2022	<1	Insulator Failure	Freezing Rain or Sleet
E5D	3/12/2022	1187	Insulator Failure	Freezing Rain or Sleet
E5	4/24/2022	<1	Unknown	Fair
E5W	8/5/2022	<1	Lightning	Thunderstorms
E5W	8/26/2022	<1	Unknown	Thunderstorms
E5E	11/19/2022	<1	Unknown	Fair
E5	3/14/2023	<1	Unknown	Snow
E5D	3/14/2023	<1	Unknown	Snow
E5D	3/14/2023	2129	Tree Fell	Snow
E5W	3/14/2023	<1	Unknown	Rain/Mild Wind
E5W	3/14/2023	1085	Unknown	Rain/Mild Wind
E5D	7/21/2023	<1	Unknown	Thunderstorms
E5D	9/8/2023	<1	Lightning	Thunderstorms
E5D	9/8/2023	<1	Lightning	Thunderstorms
E5E	1/7/2024	<1	Unknown	Snow
E5E	1/7/2024	<1	Unknown	Snow
E5E	1/7/2024	<1	Unknown	Snow
E5W	4/4/2024	<1	Unknown	Snow
E5E	6/26/2024	1	Unknown	Rain/Mild Wind
E53	7/4/2024	2	Unknown	Fair

Table 2-3: F6 Line Outage History, 2019-2024

Circuit	Outage Date	Outage Duration (Minutes)	Cause	Weather
F6W	2/25/2019	1567	Tree Fell	Fair/Severe wind
F6W	3/31/2019	< 1	Tree Fell	Fair/Calm to light wind
F6E	7/6/2019	< 1	Lightning	Thunderstorms
F6W	7/17/2019	< 1	Lightning	Thunderstorms
F6E	8/18/2019	< 1	Insulator Failure	Fair/Mild wind
F6W	8/19/2019	< 1	Lightning	Thunderstorms
F6	9/5/2019	< 1	Unknown	Fair/Calm to light wind
F6W	10/31/2019	878	Broken Tree Limb	Light rain/Strong wind
F6	3/30/2020	< 1	Device Failure	Fair/Calm to light wind
F6W	4/13/2020	< 1	Weather, Wind	Heavy rain/Mild wind
F6	6/29/2020	< 1	Lightning	Thunderstorms
F6W	7/22/2020	2	Lightning	Thunderstorms
F6E	8/4/2020	1017	Device Failure	Heavy rain/Major Storm
F6E	8/23/2020	< 1	Lightning	Thunderstorms
F6	8/23/2020	< 1	Lightning	Thunderstorms
F6W	10/27/2020	2	Unknown	Fair/Calm to light wind
F6W	3/1/2021	8	Weather, Wind	Fair/Strong wind
F6	5/31/2022	< 1	Lightning	Thunderstorms
F6W	8/26/2022	< 1	Unknown	Thunderstorms
F6E	12/30/2022	905	Unknown	Fair
F6W	2/24/2023	< 1	Unknown	Fair
F6W	3/4/2023	< 1	Unknown	Snow/Mild wind
F6W	3/14/2023	2392	Tree Fell	Snow/Mild wind
F6	6/15/2023	< 1	Device Failure	Fair
F6W	7/21/2023	< 1	Unknown	Thunderstorms
F6W	9/8/2023	< 1	Lightning	Thunderstorms
F6W	9/8/2023	< 1	Lightning	Thunderstorms
F6E	1/7/2024	<1	Unknown	Snow
F6W	4/4/2024	1	Unknown	Snow
F6E	7/4/2024	2	Unknown	Fair

As shown in Tables 2-2 and 2-3, the E5 Line experienced 40 momentary or sustained outage events in the most recent six-year period, while the F6 Line experienced 30 such events during that time period[4]. In comparison, 85% of NEP's transmission lines experienced five or fewer events during this period, and only 5% experienced ten or more events. The E5/F6 Lines are on the list of the top 10 Worst Performing NEP Circuits every year[5].

The above tables also show that 11 transmission line outages resulted in extended customer outages. In 2023, two outages on the E5 Line were approximately 18 and 35 hours long and one outage on the F6 Line was approximately 40 hours long. Note that even momentary outages may

[4] A momentary outage is an automatic outage with a duration of less than one minute that the transmission system can return to service without further intervention. A sustained outage is an outage with a duration greater than a minute that typically requires corrective action along a circuit prior to re-energization.

[5] NEP annually ranks the performance of its transmission lines based on their importance to the transmission system and the frequency of incidents over a rolling five-year period. This ranking is used to identify transmission lines in urgent need of improvement to maintain customer reliability.

have significant impacts on customers with sensitive equipment that must be taken offline or could be damaged by momentary voltage fluctuations.

Table 2-4 summarizes the causes of the outages on the Existing Lines during the 2019-2024 period.

Table 2-4: Line Outage Counts by Cause, 2019-2024

Line	Cause						
	Lightning	Weather/Wind	Vegetation/ Tree	Insulator Failure	Unknown	Device Failure	Total
E5	14	1	7	3	15	0	40
F6	10	2	4	1	10	3	30
Total	24	3	11	4	25	3	70

As shown in Table 2-4, lightning strikes accounted for 24 events, while 11 were attributed to interference with vegetation or trees. Three outages occurred during storms but could not be tied definitively to either lightning strikes or vegetative interference. In 25 cases, no cause could be definitively identified; however, at least some of these may be associated with either lightning strikes or vegetative interference. Given that most outages on the Existing Lines are associated with consequences from storm conditions, these outages are likely to continue – perhaps exacerbated by an increase in storm frequency and intensity due to climate change unless the Existing Lines are rebuilt with new, more resilient structures. The outages not the result of weather-related conditions demonstrate the general deterioration of the Existing Lines.

2.3.2 Design Issues Impacting Reliability

The design of a transmission line is of paramount importance because it affects its ability to provide reliable service under current and future transmission line load requirements. Most of the structures on the Existing Lines are the original construction, installed when the E5/F6 Lines were first energized in the early 1900s. However, best practices and standards for designing, constructing and operating transmission lines have evolved over time.

While the Existing Lines were first energized over a hundred years ago, portions of the E5/F6 Lines were refurbished in 2001. The refurbishment project consisted of replacing conductors and insulators from Millbury to Ware Substations and adding extensions to all lattice towers to enable the shield wire to be replaced with OPGW. In addition, as part of the refurbishment project, approximately 10% of the lattice towers were replaced with steel poles.

Finally, in 2019, the manufacturer of the insulators recommended that they be replaced because of manufacturing defects that cause premature deterioration, which could lead to safety and reliability issues. In 2019 and 2020, the Company replaced all the insulators with manufacturing defects and some of the remaining insulators on the E5/F6 Lines, totaling approximately 50% of the Existing Lines.

As discussed below, notwithstanding the refurbishment project, some inherent design features of these older lines can only be remedied by replacing the lines.

2.3.2.1 Need for Improved Resiliency from Lightning

Transmission lines require protection against direct lightning strikes to the electrical conductors that can cause severe damage. Accordingly, transmission lines must be designed with ground or

shield wires of adequate mechanical strength, which are appropriately located on the structure to properly shield the conductors.

The shield wire functions to intercept direct strikes to the conductors within a protective area beneath it. The area of greatest protection is measured by the shielding angle – i.e., the angle between a vertical line drawn through the shield wire at the attachment point on the structure and a line between the shield wire and the outermost conductor that is to be protected. Figure 2-3 below illustrates the concept of shielding (protecting) angle.

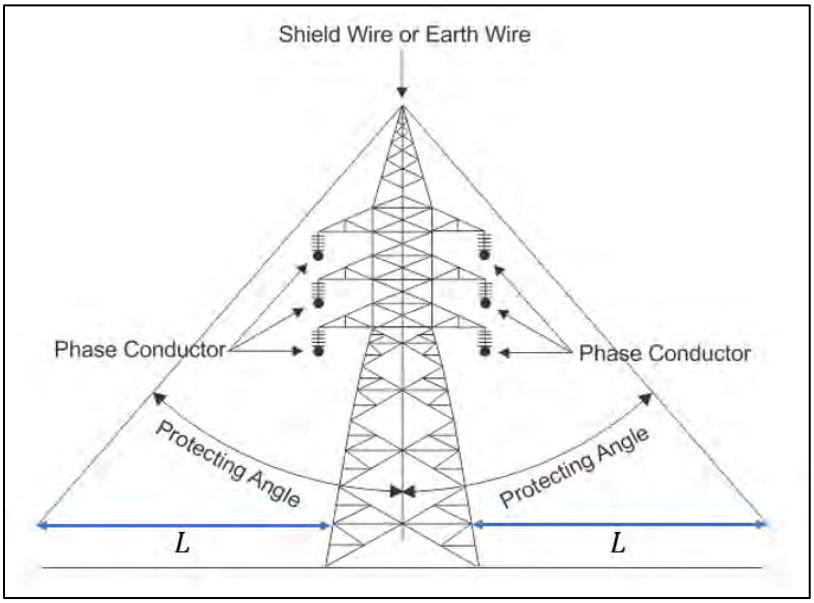

Figure 2-3: Diagram of the Shielding (Protecting) Angle

The smaller the shielding angle, the more directly under the shielding wire the conductors are, and the greater the protection of the conductors from lightning strikes. Lines with a greater shielding angle are more likely to have the conductors struck by lightning causing a flashover[6]. Extensions were installed on the existing structures when they were refurbished in 2001; however, even with the line extensions, the height of the structures still does not provide a sufficient shielding angle to adequately protect the E5/F6 Lines. The steel lattice towers on the Existing Lines have an approximately 40-degree shielding angle and the steel pole structures on the Existing Lines have an approximately 46-degree shielding angle.

National Grid policy and industry practice is to restrict shielding angle to 30 degrees or less, which allows the shield wire to intercept lightning strikes prior to the lightning hitting an energized conductor and, thus, significantly reduces the potential for a flashover creating an outage. Per Section 16.3 of National Grid Standard GL.06.01.121 Transmission Line Design Guide:

> For new construction at all transmission voltages, overhead groundwire(s) shall be utilized to protect the circuit from lightning strikes. The shielding angle shall

[6] A flashover is an unintended high voltage electric discharge over or around an insulator or sparking between two or more adjacent conductors. A flashover can cause damage to the line and nearby equipment, as well as interrupt service

> be no larger than 30°. For spans subjected to increased lightning activity, e.g., exceptionally long spans and river crossings, a smaller shielding angle should be considered. Deviations from the above may be appropriate in certain locations, such as in the vicinity of airports or where the circuit is naturally shielded by trees or other transmission lines but shall be made only with the approval of Transmission Line Engineering.

The use of a maximum 30-degree shielding angle is considered good utility practice and is recommended by the Rural Utility Service in Chapter 8 of Bulletin 1724E-200, which is broadly used by a number of utilities as a guideline for their standards.

Thus, the shielding angles on the Existing Lines is much greater than the current 30-degree standard for shield wire angles and provides insufficient shielding from lightning, which is consistent with, and predictive of, the types of outage events experienced on the Existing Lines. As shown in Table 2-4, lightning strikes account for one third of total line outages in the 2019-2024 period – and perhaps more, since some the outages attributed to "weather" and "unknown" may well be unidentified lightning strikes.

The only way to decrease the shield angle from the existing 40- or 46-degree angles is to increase the distance on each structure between the shield wire and the conductors. Adding extensions to the Existing Lines is not a feasible solution because pole extensions would add increased weight and introduce structural deficiencies. The only practical way to remedy this inherent structural design issue is to replace the existing structures with taller structures that will provide a shielding angle of less than 30 degrees. In addition, the Existing Lines are constructed with only one shield wire. The Project will include two OPGWs, one for each circuit, which will shield both lines from lightning strikes.

Another design feature of the Rebuilt Lines is that they will have more insulation and, therefore, will provide greater protection against lightning strikes. The Company is proposing construction of the Rebuilt Lines to a 115 kV design, which increases the length of the insulators in a conductor assembly as compared to the 69 kV design. While this requires a slightly higher structure, the additional insulation provides greater protection against a back-flashover across the insulation should a structure or shield wire be hit by lightning. When lightning contacts a shield wire, a traveling current wave is created, which in turn induces a traveling voltage wave. This traveling voltage wave typically increases in magnitude as it travels down the wire until it reaches a grounded element (transmission structure). The grounded transmission structure creates a reflection of the traveling voltage wave, which serves to cancel it out and prevents the traveling voltage wave from increasing. If the traveling voltage wave is of sufficient magnitude, the air gap between the energized conductors and grounded structure arm can be breached, creating a back-flashover of the insulators resulting in an outage. The greater the insulation, the lower the probability of occurrence of this event.

Lastly, the increase in spacing between conductor phases on the Rebuilt Line will reduce the potential for voltage induced by a lightning strike that travels to a single conductor from flashing over to an adjacent conductor. The vertical configuration of conductors on the Existing Lines has each arm that supports a conductor being the same length. The spacing between two adjacent phases of each circuit, as well as the space between one phase and the structure arm supporting the phase below, do not meet current applicable safety codes, including the National Electrical Safety Code ("NESC") and 220 CMR 125. The reduced vertical space between the two adjacent phases

of the conductor reduces the amount of insulation that can be placed between the conductors and the structure, which increases the line's susceptibility to lightning- and tree-caused outages. The current practice is to stagger the arm lengths of a delta configuration so that the conductors are not in a straight vertical line, which increases the space between the conductor phases. Staggering the arm lengths reduces the likelihood of conductor contact or flashover due to galloping (large amplitude conductor motion caused by snow or ice on the line and a steady wind) or ice shedding (sudden vertical conductor motion caused by ice falling off the lines).

In summary, the Project will replace the existing structures with taller structures with staggered arms, which will provide additional space to separate the shield wire/OPGW from the conductors and, therefore, decrease the shielding angle. In turn, the reduced shield angle will provide greater protection from lightning strikes to the conductors. The increased height of the structures on the Rebuilt Line will also allow longer suspension insulator strings to be installed, and greater spacing between conductor phases, each of which contributes to increased resilience to lightning events.

2.3.2.2 Interference from Vegetation

The height of structures, together with the location of structures on a ROW, contributes to a transmission line's reliability. If the structures are lower than adjacent off-ROW vegetation (i.e., trees not within the Company's control to manage), the line will be susceptible to interference from vegetation. When these trees fall or drop limbs during periods of high winds, they contact the existing conductors and cause either momentary or sustained outages.

These conditions exist on the Existing Line. The close proximity of tall trees along, but outside, the ROW contributes to the high frequency of tree-related outages on the Existing Lines. The configuration of the Existing Lines is generally vertical. Additionally, the elevation of the lowest existing conductor above grade is typically the minimum necessary to conform with the governing code. In many areas, the abutting land just beyond the ROW is densely vegetated with tall-growing species that exceed the height of the existing structures. As a result, when a tall-growing tree located outside the bounds of the ROW falls or drops limbs across the width of the ROW, there is a high probability that the vegetation will contact at least one phase and potentially both circuits supported by the existing structures, causing outages. As shown in Table 2-2 above, one of the longest outages of the last six years occurred on March 14, 2023, which lasted for approximately 36 hours and was caused by tree damage that took down both the E5 and F6 Lines. Replacing the existing structures with taller structures will decrease the likelihood of fallen vegetation causing outages.

While the Company performs frequent vegetation maintenance along the E5/F6 ROW (in addition to the regular five-year cycle for tree trimming and hazard tree removal), the dense off-ROW vegetation and the poor access road condition make these efforts insufficient. Rebuilding the line on taller and narrower structures, will reduce the likelihood of trees falling on the line.

2.3.3 Asset Condition

In addition to the inherent design issues discussed above, the deteriorating physical condition of the Existing Line structures also supports the need for the Project. Every five years, the Company conducts a ground level inspection of its transmission line assets to assess their condition and determine maintenance or refurbishment needs.

In 2019, NEP conducted a review of the physical condition of the Existing Lines and Tap structures to identify any issues that might negatively affect the service reliability of the lines. Approximately 34% of the structures on the Existing Lines and Taps were visually inspected at strategic locations. This was supplemented by an aerial inspection of all structures along the full length of the E5/F6 Lines and Taps. The inspections identified that the main issues on the lattice towers involve foundation damage, corrosion, bent/bowed components of the towers, and paint degradation. Steel poles issues include foundation damage and the proximity of dense vegetation. Wood poles show signs of deterioration due to pole top rot, and significant woodpecker activity was present at nearly every wood structure examined. Overall, the inspections indicate that woodpecker activity and other damage compromise the integrity of many structures on the Existing Lines. The deteriorated condition of these more than century-old structures supports their replacement.

The most recent cyclical inspection done in April 2022 supports these findings. Bent cross members and deteriorating foundations were observed on the lattice towers and continuing pole rot and woodpecker damage were observed on the wood structures. The inspection also identified broken insulators, missing ground wire and loose bolts on hardware.

2.4 Need For Enhanced Fiber Optic Capability

OPGW is a dual functioning cable that both acts as shield wire and contains optical fibers that are used for telecommunications purposes. Only a portion of the Existing Lines has OPGW, between the Deerfield #4 Substation and Structure #322 at the southern tip of the Quabbin Reservoir. The substations along the remaining portions of the Existing Lines are presently communicating through microwaves. The single existing OPGW is insufficient to provide adequate shielding and does not provide adequate telecommunications capabilities. Rebuilding the Existing Lines will enable the Company to install two OPGWs on the Rebuilt Lines and Taps in place of traditional shield wire, one for each of the circuits. The OPGWs will be placed in the topmost position of the transmission structure where they will shield the conductors from lightning while providing a telecommunications path to connect the substations along the transmission corridor.

In the OPGW cable, the optical fibers are surrounded by layers of steel and aluminum wire. The OPGW fibers are more reliable and secure than the microwave connections currently used for communication purposes on most of the Existing Lines because they are less affected by environmental factors, such as weather, noise or other obstacles. Moreover, OPGW fibers are harder to tap or hack because they do not radiate signals outside the cable. Microwave connections, on the other hand, are more vulnerable to interference and can be easily intercepted or disrupted.

Improving fiber optic coverage in the central Massachusetts area will allow NEP to phase out microwave and leased communication services between several substations in the area, improving communications and fault protection reliability. Fiber optic communication is used by NEP in the daily operation of the transmission system elsewhere on its system and it is becoming critically more important to manage the transmission system as automation and system condition monitoring equipment become more prevalent and involved in the management of transmission system operations.

By enabling direct high-speed communication between relays at each substation, OPGW can be used to monitor substations and remotely operate transmission system components (switches, breakers, etc.). It is also used to remotely access digital fault recorders and relay information without physically visiting a substation, which enables the Company to more quickly diagnose,

locate, and repair faults more quickly and cost-effectively. In addition, transmitting data between and among substations and control centers via OPGW is more secure and can be less costly than using public communications network services. Lastly, OPGW provides a communication path for substation security monitoring (cameras, access control, gunshot detection systems, etc.).

Adding OPGW to the existing structures is not feasible because the structures would not be able to support the weight of the additional OPGW. During the 2001 refurbishment project, increased loads associated with the larger conductor size utilized nearly all the available structural capacity of the existing towers. Hypothetically, it may be possible to modify the existing structures that are not already in deteriorating condition, to increase their structural capacity to support OPGW; however, these modifications would be extensive and labor-intensive, negating any savings compared to replacement of the structures with new structures designed to support two OPGWs.

2.5 Long Term Benefits

The proposed Project, with the ability to operate at 115 kV in the future should circumstances warrant, would provide the additional transmission capacity and voltage support needed along the E5/F6 corridor[7] to provide for increased electricity usage and the interconnection of future DER. With power delivery expectations on the power system increasing, and with high volumes of new devices and energy sources connecting to the system, NEP must ensure that the condition of the infrastructure does not become an obstacle to achieving its own, as well as state and regional, climate change goals. There will likely be a future need for additional transmission resources along the E5/F6 corridor to facilitate anticipated interconnection of solar photovoltaic and battery energy storage solution projects as well as increased load.

Over the next several decades, renewable resources like wind and solar photovoltaic generation are expected to substantially displace natural gas-fired generation as the region's primary resource, while at the same time, increased electrification is expected to significantly increase overall consumer demand for electricity and drive changes in usage patterns, including seasonal and daily shifts in peak demand. One of ISO-NE's responsibilities is ensuring the regional power system continues to operate reliably as system conditions change. Transmission planning helps to maintain system reliability and enhance the region's ability to support a robust, competitive wholesale power market by moving power from various internal and external sources to the region's load centers.

To facilitate a smooth, reliable clean energy transition, ISO-NE, in coordination with the New England States Committee on Energy, undertook a study of the ways in which the transmission system in New England may be affected by changes to the power grid. On February 12, 2024, ISO-NE issued the results in a document entitled "2050 Transmission Study" (provided as Appendix 2-1"), a comprehensive long-term regional transmission study undertaken to help inform stakeholders of the amount and type of transmission infrastructure necessary to provide reliable, cost-effective energy to the region throughout the transition to clean energy. The 2050 Transmission Study points to a long-term need for additional capacity across the New England transmission system to support long-term electric load growth driven by these regional

[7] "ROW" and "corridor" are both used to identify land currently owned/operated and managed by NEP and other utilities for transmission and sub-transmission assets. These terms will be used interchangeably throughout this section.

commitments. The 2050 Transmission Study concluded that assuming increased buildouts of renewable energy resources continue, and electrification of heating and transportation proceeds as expected, the region's aging transmission system has the potential to become a significant bottleneck to progress if it does not keep pace with changes to other elements of the power system. Thus, based on expectations from the 2050 Transmission Study, it is likely that the Existing Lines would become overloaded if not rebuilt. In addition, in recent years, developers have proposed over 550 MW of DER projects that would interconnect at more than 35 National Grid substations in central and western Massachusetts, including seven substations along the E5/F6 transmission corridor. NEP conducted a series of system impact studies ("SIS") to determine whether the interconnection of these projects would result in a significant adverse impact on the reliability, stability and operating characteristics of the New England bulk power transmission system and the National Grid transmission system. These SIS consisted of thermal, voltage, stability, and short-circuit analyses for three successive groups of proposed DER projects, known as Groups 1, 2 and 3. This series of studies is known collectively as the "Western Massachusetts Cluster Studies."

In June 2022, NEP issued its "Transmission System Impact Study Results for Group 3 of DER Additions in Western Massachusetts" ("Group 3 Cluster Study"), which is provided as Appendix 2-2. This study assessed the transmission system impact of interconnecting DER projects that were proposed since the Group 2 Cluster Study was issued, including a 40 MW solar project that would interconnect along the E5/F6 transmission corridor. The Group 3 Cluster Study found that interconnection of Group 3 DER projects along the E5/F6 Lines would result in violations of thermal reliability criteria for the Existing Lines, if the 40 MW solar facility in the ISO-NE Federal Energy Regulatory Commission ("FERC") generator interconnection queue were to be built. Although the proposed project has since withdrawn from the queue, it is likely that any future projects proposed along the E5/F6 transmission corridor would overload the Existing Lines. Consequently, this suggests a future need for additional transmission capacity along the E5/F6 corridor to support the interconnection of DER projects.

2.6 Conclusion

NEP is obligated to ensure the safe and reliable delivery of electricity to customers and the transmission of electricity to support regional electricity markets. Accordingly, the Company employs a forward-looking approach to asset management whereby it evaluates asset conditions to determine which assets should be replaced before their performance negatively impacts the provision of safe and reliable service.

The Existing Lines were built in the early 1900s to carry network power flows and supply distribution load-serving substations in western and central Massachusetts. Today, these more than century-old transmission lines continue to bring hydropower to Massachusetts and also serve as the sole transmission source for electric customers in 26 Massachusetts cities and towns. Despite their importance, the Existing Lines are among the least reliable lines on the NEP transmission system, consistently experiencing an unusually high rate of outages associated with lightning, vegetation contacts, and weather events.

This outage rate reflects both design issues inherent with the existing structures as well as the existence of tall, dense vegetation along many parts of the E5/F6 ROW that likely contributes to the frequency with which downed trees and dropped limbs interrupt power flow on the Existing Lines. The lightning masts and single shield wire on the Existing Lines are inadequate because the

shield angle does not meet current standards, and it is impossible to improve the shielding angle needed to properly protect the lines from lightning strikes while retaining the existing structures. In addition, many of the existing structures are in poor or deteriorating physical condition.

Repairing or replacing structures on a structure-by-structure basis would not allow the Company to address existing design issues and, therefore, would likely not significantly reduce outages. Completely rebuilding the Existing Lines with new, taller structures, with improved phase spacing, additional insulation and two OPGWs will reduce exposure to tree falls, dropped limbs, and provide greater resiliency from lightning and inclement weather impacts. Rebuilding the Existing Lines will not only improve reliability, but the new structures will have sufficient structural capacity to support OPGW that will provide an upgraded communications path between NEP's Millbury and Deerfield #4 Substations.

Further, with power delivery expectations on the power system increasing, and with high volumes of new devices and energy sources connecting the system, transmission infrastructure must not become an obstacle to achieving NEP's, state, and regional climate change goals. For all of the above reasons, the Project is needed to address the condition of the Existing Lines to improve their performance and ensure reliable service to the Company's electric customers.

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