EVERSOURCE ENERGY

To: New England States Committee on Electricity

From: Eversource Energy

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Subject: Memorandum Response to NESCOE's July 7, 2023, Letter Regarding the 1704/1722 Underground Cable Replacement Project

Cc: ISO-NE; Planning Advisory Committee

Background

Eversource's transmission system in Hartford consists primarily of two underground 115-kV cables, generally beneath city streets. The cables are located within a direct-buried steel pipe and insulated with a pressurized dielectric fluid (mineral oil) and a paper tape system impregnated with the oil. These installations are commonly referred to as pipe-type cable (PTC) or high-pressure fluid filled cable (HPFF). Across its entire service area in New England, Eversource operates over 2,300 miles of transmission corridors and rights-of-way, of which approximately 440 circuit miles are underground cable. The older underground lines consist primarily of PTC, totaling approximately 300 circuit miles, which is divided approximately evenly between Pool Transmission Facility (PTF) circuits and non-PTF circuits. Over the years, and as technology advances in underground cable have been made, the utility industry (including Eversource) has moved to the use of solid dielectric cross-linked polyethylene (XLPE) insulated cables as the standard for underground transmission line construction. In contrast to transmission lines using HPFF technology, transmission lines using XLPE cables are typically installed in a concrete-encased ductbank containing multiple polyvinyl chloride (PVC) conduits. For a three-phase circuit, three conduits are required (one phase cable per conduit) and spare conduits are often installed to facilitate repairs.

On June 15, 2023, Eversource presented proposed replacements of the two subject underground transmission cables (Lines 1704 and 1722) within the City of Hartford, Connecticut, to the ISO New England Planning Advisory Committee (PAC). Eversource proposes to replace the existing underground HPFF cables with new cables utilizing XLPE technology.

On July 7, 2023, Eversource received a letter from the New England States Committee on Electricity (NESCOE) requesting additional information on the Hartford cable replacement projects. This memo provides responses to the questions NESCOE posed in its letter. For completeness, this memo also repeats certain information from Eversource's June PAC presentation. Eversource looks forward to discussing the information presented in this memo with NESCOE and regional stakeholders at the

August 16, 2023 PAC meeting. Below are Eversource's responses to the key questions raised in NESCOE's letter.

Additional Information on Alternatives Considered

Eversource considered several alternatives in the design phase of these projects. Eversource's analysis of these alternatives is described in more detail below.

Reconductoring Existing HPFF

Under this alternative, Eversource would remove the existing HPFF cables from the existing pipe and drain the dielectric insulating fluid. Eversource would then assess the condition of the existing pipes and make any necessary repairs, including replacing sections of the pipe, if necessary. Eversource would also repair or reconstruct splice vaults, as needed.[1] The existing HPFF conductor is past the industry-accepted life span of 40 years and as such cannot be reused. After completing these modifications, Eversource would install new HPFF cables in the pipes and repressurize with dielectric insulating fluid.

This alternative was removed from consideration early in the development process for several reasons.

First, there is only one global supplier left that produces PTC equipment, and that company has stated that it is considering discontinuing production of PTC technology. The forthcoming obsolescence jeopardizes the ability to maintain a reliable and continuous inventory of replacement equipment. As this transition is occurring, technicians with experience maintaining and repairing PTC equipment are also becoming increasingly scarce.

Second, if an HPFF cable fails, repairs can take several weeks, compromising the reliability of the area transmission system. This is because HPFF repairs require excavations to locate and repair faults, and involves the time required to freeze the dielectric fluid within the cables while repairs are made.

Finally, HPFF systems utilize a pressurized dielectric insulating fluid surrounding the HPFF cables. With the presence of pressurized insulating fluids comes the increased risk of a release. If a release would occur, Eversource maintenance teams would need to take the transmission facilities out of service, locate the point of the release, conduct repairs, and perform the necessary response and clean-up to minimize and address impacts to the environment.

While these challenges were acceptable when PTC was a state-of-the-art technology, other cable technologies that do not have these issues, such as XLPE, are now widely available and utilized by the industry. XLPE does not use dielectric insulating fluid and can usually be repaired via existing manholes without requiring excavation and freezing, thus any needed repairs can usually be completed in shorter timeframes.

Because the HPFF alternative was removed from consideration due to technological obsolescence and viability concerns, and not due to cost, Eversource did not initially develop a cost estimate. In response

[1] Eversource performs routine vault inspections and maintenance on a scheduled basis. Vault health, while a factor, is not the primary driver for Eversource's plan to move away from HPFF as our primary technology for underground transmission replacements.

to NESCOE's request, Eversource developed an "order of magnitude" cost estimate of approximately $65 million (-50%/+200%) for this alternative based on prior projects to reconductor HPFF lines. This estimate assumes minimal costs associated with the repair of existing pipes which, as described above, cannot be evaluated until the existing HPFF cables are removed and the dielectric fluid drained. If major repairs are required, the cost would be significantly higher. Additionally, as described above, pursuing this alternative would result in a substantial investment in an obsolete technology (HPFF cable) that may be discontinued.

Reconductor With XLPE Within Existing Pipes

Under this alternative, Eversource would remove the existing HPFF cables and repair the existing pipes as described above. Eversource would then install new XLPE cables within the existing steel pipe. This would be challenging because XLPE cable is larger in diameter than HPFF cable with similar ratings. As a result, this alternative would require Eversource to install a smaller XLPE cable with higher AC resistance and lower thermal capacity than the existing HPFF cable. The reconductored lines would have lower thermal ratings than the existing lines, which would be unacceptable. In addition, even if XLPE cables with sufficient ratings could be installed within the existing pipes, this alternative would present additional cost and reliability concerns. As described above, the condition of the existing pipe is unknown until the existing cable is removed, resulting in a higher risk of unanticipated costs. Additionally, it would require use of a non-standard, sole-sourced XLPE cable design unique to a specific cable manufacturer that has not yet been fully vetted in industry.

Because of these concerns, this alternative was removed from further consideration and no formal cost estimate was developed.

Replacement With XLPE

Under this alternative, Eversource would construct concrete-encased ductbanks with PVC conduits and new splice vaults. Eversource would install new XLPE cables within the new ductbanks. The existing HPFF lines would stay in-service while their replacements were constructed and would be retired after the new lines were completed, minimizing outage time during the project. Eversource would utilize industry-standard components for which there is a robust and competitive supplier marketplace.

Within this alternative, Eversource considered the use of XLPE with 5000-kcmil aluminum conductor and XLPE with 5000-kcmil enameled copper conductor. Both options are standard cable sizes currently in-use by Eversource on other facilities, though no installations of aluminum conductor XLPE currently exist in Connecticut. Cost estimates for these options are provided in Table 1, below.

Table 1: Cost Estimates for XLPE Cable Options (-25%/+50%)[2]

Cable Type	1704 Line	1722 Line	Total
5000-kcmil aluminum XLPE	$161.1M	$126.1M	$287.2M
5000-kcmil copper XLPE	$169.3M	$132.3M	$301.6M
Difference:	$8.2M	$6.2M	$14.4M

Because these cable options had comparable estimated costs, Eversource considered other factors in selecting a preferred option. ISO New England's 2050 Transmission Study indicates that New England will shift from a summer peaking region to a winter peaking region as early as the 2030s and load growth in the Hartford area could result in thermal overloads on the Hartford cables as soon as 2040. In addition, Eversource internal analysis shows similar thermal overloads resulting from electrification load growth over the long-term. The anticipated Long-Term Emergency (LTE) ratings from copper conductor XLPE (see Tables 2 and 3, below) would likely be sufficient to support forecasted cable loads through at least 2050. However, aluminum conductor XLPE ratings could be inadequate by 2050. On this basis, Eversource selected copper conductor XLPE as the preferred option.[3]

Table 2: Anticipated cable winter ratings

Cable Type	1704 Line	1722 Line
5000-kcmil aluminum XLPE	Normal: 326 MVA LTE: 387 MVA	Normal: 339 MVA LTE: 392 MVA
5000-kcmil copper XLPE	Normal: 392 MVA LTE: 474 MVA	Normal: 407 MVA LTE: 480 MVA

Table 3: Anticipated cable loading

2050 Study Case (Worst N-1-1 Contingency)	Existing HPFF LTE Rating (MVA)	Preliminary 5000-kcmil Copper LTE Rating (MVA)		MVA Loading	
	1704/1722	1704	1722	1704	1722
2040 Summer Eve Peak A	277	422	435	251	263
2050 Summer Day Peak				248	277
2050 Summer Eve Peak A				261	267
2040 Winter Peak		474	480	305	332
2050 51K Winter Peak				356	383
2050 57K Winter Peak				418	466

[2] Implied per-mile costs for the Hartford cables should not be extrapolated to the costs of other potential future projects. For example, while the Hartford cables are single circuits, many other cables are installed as double-circuit pairs. Because of construction efficiencies, the per-circuit-mile costs to construct a double-circuit ductbank are lower than the per-circuit-mile costs to construct a single-circuit ductbank.

[3] Eversource believes that this approach is consistent with the evaluation of project alternatives described in Section 4 of Attachment K to the ISO-NE Open Access Transmission Tariff, specifically the consideration of "future system expandability" as one factor in solution selection, while acknowledging that asset condition projects are not subject to the requirements of Attachment K.

Consideration of Future Needs

Eversource initiated these HPFF replacement projects to address asset condition concerns, not in response to the 2050 Transmission Study or any other transmission planning study. Eversource's only use of the 2050 Transmission Study was to inform the selection of conductor materials for the preferred solution given the comparable cost estimates between aluminum and copper conductor options. Eversource included a portion of this analysis in the June 15, 2023 PAC presentation in anticipation of stakeholder questions about the intersection of these projects with potential future needs. Additionally, as described above, Eversource selected XLPE as the preferred technology for these projects to avoid perpetuating dependence on HPFF, which is an outdated technology with several known issues.

Prioritization of Other Pipe-type Cable Replacement Projects

Eversource has PTC systems in a variety of locations within its service area in Massachusetts and Connecticut. The majority of Eversource's PTC facilities are located in the Boston area, with a more limited number of facilities dispersed throughout other locations in Massachusetts, such as New Bedford and Springfield. Eversource's PTC facilities in Connecticut include those in Hartford, Danbury, and several Southwest Connecticut locations.

Eversource continues to evaluate the population of HPFF cables on its transmission system, recognizing that maintaining a large network of HPFF transmission lines is not sustainable in the long term, for reasons explained above. Eversource is developing an approach to gradually replace HPFF cable in a prioritized manner over the next several decades. Eversource expects that taking a gradual approach will result in lower operational, community, and ratepayer impacts without overstressing limited engineering, cable supply, and civil construction resources. Eversource is aware of at least one other electric utility (Tokyo Electric Power Company) that is engaged in a complete replacement program for its HPFF cables for similar reasons.

Eversource intends to share with PAC for feedback later this year a proposed approach to replacing Boston-area HPFF cables and an initial prioritization of these replacements. Other than the Boston-area and Hartford lines, Eversource's pipe-type cables are either radial (non-PTF) or are not high priorities for replacement.