STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF

CENTRAL MAINE POWER COMPANY)
NEW ENGLAND CLEAN ENERGY CONNECT)
#L-27625-26-A-N/#L-27625-TG-B-N/)
#L-27625-2C-C-N/#L-27625-VP-D-N/)
#L-27625-IW-E-N)

Intervenor Group 3 Response to the Department of Environmental Protection's Tenth Procedural Order: Supplemental Testimony by Gil A. Paquette

May 1, 2019

My name is Gil A. Paquette. Please refer to my sur-rebuttal testimony filed on April 19, 2019 in this proceeding ("Paquette Sur-rebuttal") for a description of my relevant qualifications and work experience. Below I address certain questions posed in Appendix A of the Department of Environmental Protection's Tenth Procedural Order, at times referring to Paquette Sur-rebuttal sections for a more fulsome discussion of the relevant topic.

Answers to Questions in Appendix A

Construction Questions:

2. Description of construction process, staging, and impacts for 100-foot or taller poles.

Answer:

A general understanding of what overhead transmission structures are used, where, and why is a helpful lens through which to answer this question. Generally, there are three types of high-voltage transmission structures: (1) tangent; (2) angle; and (3) termination or dead-end. Tangent structures are used for straight-line segments and are typically monopoles, H-frames, or lattices, each with different attributes that suit them for particular types of locations. Monopoles are single poles that require less ROW width than, for example, H-frames. For voltages as high as the NECEC, monopoles are typically made of steel, making them relatively expensive but strong. Depending on height, monopoles can be directly imbedded into the substrate with or without guying[1] for stability. Monopoles are considered less visually impactful compared to H-frames and most termination structures. H-frames are comprised of two vertical poles with a crossarm connecting their mid-points and are typically made of relatively inexpensive wood. H-frames provide additional stability with their wide base but require relatively more ROW and to some are considered more visually impactful. Lattices are typically extremely strong steel structures similar in form to the Eiffel Tower. Lattices are often the tallest tangent structures used to span the greatest distances, commonly in the flat agricultural areas of the Midwest or for long river crossings. Though lattice structures themselves are more expensive, their use can reduce the total number of structures because they are typically used for longer spans. However, lattices are by far the most industrial, visually striking of the tangent structures.

Angle structures are used when a transmission line changes direction by as little as one or two degrees. These structures must be fortified to distribute the load of the conductor going from one direction to another. In the case of the NECEC, angle structures could take a few forms. There could be two monopoles, each with a concrete foundation. There could also be two monopoles, each with guy wires that anchor the poles to the ground so that the monopoles are not pulled downward by the load of conductor. A single monopole with a concrete foundation is another option.

Finally, termination or dead-end structures are used to create a "break-away" point that limits cascading damage. For example, after 5 continuous miles of spliced conductor, a conductor would typically be terminated on a dead-end structure so that if a tangent structure preceding the termination structure failed, the failure would could not cascade beyond the break-away point and overall damage to the transmission line could be contained. To protect the overall transmission line from cascading, dead-end structures are more robust than a tangent or angle structure, as they need to withstand a cascading event and not collapse under the weight of the conductor that is

[1] Guying in this context refers to the use of a tensioned wire designed to add stability to a free-standing structure (i.e., a structure that is not attached to a foundation). Guy wires are attached to the pole and the other end is anchored to the ground a certain distance away, at roughly a 45-degree angle.

being pulled down by the portion of the line that is cascading. Dead-end structures for an overhead transmission line are either guyed or have concrete foundations.

As currently proposed, the NECEC would involve the use of monopoles for its tangent structures, with an average height of about 94 feet (though some poles would be slightly taller). Each pole would be directly imbedded into the substrate. Burial depth is a function of pole height and, to some extent, the backfill used for the excavation. For steel poles, a common rule of thumb for burial depth is 10 percent of the pole height plus 4 feet of the length of the pole. For example, a 94-foot steel pole would be buried 13.4 feet deep. No concrete foundations or other forms of support like guy wires would be necessary, unless there were extenuating circumstances.

Assuming similar monopole tangent structures, there is no material difference in the construction process, staging, and environmental impacts for poles that are less than 100 feet tall and poles that are up to about 120 feet tall. However, I assume the purpose of asking about "100-foot or taller poles" would be to allow for full vegetation height below the transmission line for the preservation of travel corridors. Pine marten, for example, would require about 30-foot-tall vegetation. To achieve full vegetation height (30 feet) and maintain the proper conductor clearance zone of approximately 26 feet below the lowest sag point of the conductor, significantly taller structures would be needed. The exact height of the monopoles is difficult to estimate, as it is a site-specific, project-specific engineering determination based on a variety of factors, including topography, span length, conductor sag, point where the conductor is attached to the insulator relative to the top of the pole, etc. I would roughly estimate that monopoles between 130 and 150 feet tall would be required to provide full-height vegetation sufficient for pine marten. As CMP proposes to use monopole steel tangent structures, I assume that the taller poles would also be monopole steel. Wood poles made from whole tree trunks are rare over 120 feet, however, laminated wood structures may be available.

Assuming monopoles 140 feet tall (the simple average of 130 and 150 feet), concrete foundations would be required, as opposed to directly embedding the structures into the ground, and therefore the construction process would be quite different. The biggest difference is the need for adequate access to allow concrete mixer trucks to access the structure locations. Concrete foundations for this application are too large for pre-casting followed by site-specific transport. Therefore, to accomplish foundation construction along Segment 1, temporary roads within the ROW of sufficient durability to withstand extremely heavy concrete mixing trucks would need to be cleared, leveled, and stabilized, likely necessitating the use of extensive matting and perhaps the construction of new or re-enforcement of existing bridges. Ideally, existing roads (most likely logging roads) crossed by the ROW, spaced at approximately 1-mile intervals, would be available for use along Segment 1 to provide access to the ROW, as this will tend to minimize environmental impacts. In addition to temporary road impacts, there would be additional environmental impacts at each pole location because a significant amount of excavation would be required to accommodate the concrete foundations, which can be as large as 10 feet in diameter and 45 feet deep (compared to a splice vault which is 28'x 8'x 8'). To the extent excavation is required near wetlands and other waterbodies, unstable soil, or bedrock, the impacts would be even greater. Please refer to Paquette Sur-rebuttal Sections D.3 and D.4 for a discussion of the logistical and environmental impacts associated with excavating near wetlands and in trench.

3. A more detailed description of undergrounding techniques including direct burial, duct bank installation, or trenchless installation. This should also include typical dimensions, materials and cross-section diagrams.

Answer:

I believe that contractors experienced with trenchless transmission installations would be the most appropriate people to address trenchless techniques and their impacts. Further, in my experience, duct banks have been used only in multi-purpose ROWs in an urban or suburban setting, i.e., a road under which various types of utility infrastructure such as electric lines, natural gas mains, water mains, and fiber optic cable are buried. In this context, duct banks provide an added layer of protection to ensure that one utility does not unintentionally damage the infrastructure of another utility while attempting to service its respective facilities. I would not expect to see duct bank installation in many areas of Western Maine, such as Segment 1, if at all. For these reasons, I will only address the direct burial technique.

If direct-burial were used for Segment 1, HVDC cables would need to be buried in a trench of varying depths but approximately 6 feet on average. The slope and width of excavation may vary due to geotechnical conditions and the terrain along the route. As explained in Paquette Sur-Rebuttal in Section D.3., a typical trench would be approximately five feet wide at the bottom with sloping sides and a minimum surface width of 14 feet, increasing when trench depth increases. This is generally true, but Occupational Safety and Health Administration ("OSHA") requirements and other variables will affect sloping and thus the corresponding width of the trench. Per OSHA, the trench would need to be sloped on each side of the trench to protect workers. Sloping requirements depend on soil type, with greater sloping required for less stable soils. Soils are generally classified into three types based on their stability (A, B, and C). Assuming a five-foot width at the base of the trench to accommodate five cables, the width of the trench opening would range from an approximate minimum of 14 feet (with the most stable soil type, A) to an approximate maximum of 23 feet (with the least stable soil type, C). In my experience, the least stable soil type, C, occurs with some frequency in Maine. Soils that are less stable than C would require shoring[2] the trench. Along Segment 1, unstable soils would generally be unavoidable and would cause many unexpected delays when encountered. Though sloping could be avoided in stable bedrock, it would be required through wetlands.

Once the cables are laid into the trench, the cable would be surrounded by a layer of imported thermal sand backfill, as described in Paquette Sur-rebuttal Section D.8. Above the sand backfill High Density Polyethylene (HDPE) "stokboard," warning tape, or both would need to be installed. This would act as a warning for someone digging in proximity to the cable, including third parties. In lieu of stokboard, concrete slabs could be placed above the thermal backfill as an extra level of protection. Depending on the type of native material excavated from the trench, some native material could be re-applied on top of the concrete slab, stokboard, or warning tape and then compacted. The remainder of the excavated material would either need to be spread in uplands or removed from the Project area and disposed of at an appropriate facility.

As the weight of the cable limits the amount that can be installed on reels (average length of 2,250 feet), separate lengths of cable would need to be spliced together and subsequently placed in a pre-cast concrete vault. Vaults would be approximately 26' x 8' x 8'. The trench excavation for the

[2] Trench shoring is the process of bracing the walls of a trench to prevent collapse and cave-ins. Several methods can be used, for example, steel plates pressed outward against the trench wall via hydraulic pressure and steel I-beams driven into the ground with steel plates slid in among the I-beams.

splice vaults will be approximately 14 feet wide at grade (though the width of excavation may be greater due to geotechnical conditions and the terrain along the route). Shoring would be used in areas with highly unstable soil conditions.

After the splice pit is excavated, pre-cast concrete vaults would be installed in the splice pit. The cables would be pulled through the vault and spliced using a temporary splice trailer situated over the vault. The splices would then assembled and placed into the vault, with thermal sand backfilled over them in the vault.

5. Whether fewer longer sections (versus more shorter sections) of the line could be undergrounded that would minimize both the number of transition stations as well as the environmental impact of the project.

Answer:

To answer this question, it is important to remind the reader of cable length restrictions due to the weight of cable. On average, the length of cable on the reels will be about 2,250 feet. As such, any "longer sections" would be limited by the length of the cable on the reel. Every termination of the cable would require splicing and thus a concrete splice vault for protection and access. It is possible to have longer sections of underground, but splice vault locations would need to be excavated and installed at every splice, approximately every 2,000 to 2,250 feet.

A useful term to understand is "porpoising"—used to describe going from an underground project to an overhead project. The electrical characteristics of HVDC allow a line to be "porpoised," whereas it is very difficult to porpoise an HVAC line. While porpoising may help to minimize or avoid certain visual and environmental impacts in certain areas, it causes different and potentially more severe visual and environmental impacts in other areas and complicates overall construction and logistics due to the need to engineer and construct large, permanent transition stations.

If there are longer underground sections, it stands to reason that there will be fewer transition stations needed to transition to an underground cable from an overhead conductor or vice versa. Fewer transition stations would equate to less overall site-specific temporary and permanent environmental impacts associated with transition stations. However, any amount of porpoising would likely create more environmental impacts compared to a purely overhead line throughout Segment 1 based on the need to erect permanent transitions stations and the greater impacts associated with undergrounding generally. Please refer to Paquette Sur-rebuttal Section D for a discussion of the greater logistical and environmental impacts associated with an underground project versus an overhead project. In general, overhead projects minimize or avoid environmental impacts to wetlands and streams and other protected natural resources. Therefore, transitioning to underground from overhead for any discrete sections of Segment 1 would not be the least environmentally damaging practicable alternative without extenuating circumstances, such as those that exist with respect to the visual and recreational impacts associated with the Kennebec Gorge.

6. Explanation of why a permanent road would need to be constructed to each splice location (undergrounding), but not for overhead poles. Explanation of why matting along the ROW (which could be used for overhead poles) could not be used for splice boxes.

Answer:

The biggest difference between overhead and underground construction is the type of equipment that would be required for installing an underground cable. For overhead construction, tracked excavators, tracked cranes, and heavy-duty pickup and bucket trucks must access the ROW. Although this equipment needs to travel within the ROW, the equipment used is specifically designed for traveling a cleared ROW without the need for building a temporary or permanent gravel road for construction. For a project like NECEC, it would be desirable to have access to the ROW from an existing road crossing of the ROW, such as a logging road, about every mile. This would allow for less travel within the ROW, as equipment would only need to travel in either direction for up to half of a mile. A temporary travel lane would be identified within the ROW, with matting used to cross wetlands and temporary bridges used to span waterbodies. Once construction is completed, mats and bridges would be removed, and the ROW would be seeded and mulched. In most situations, after one growing season, the temporary travel lane and work pads at the structures would be stable and vegetated.

Overhead construction can move relatively quickly compared to underground construction because excavation is only required at pole locations and, as planned, the NECEC would not require the use of pole foundations for very tall poles. Overhead construction also provides leeway to avoid many, if not all, sensitive areas (e.g., streams and wetlands) through thoughtful spacing of poles and spanning of the conductor. For example, if there is a waterbody that is too wide for the installation of a temporary bridge, access to pole locations can be made on other side of waterbody, thus avoiding a crossing. This is also true for wetlands, such as peat bogs, where the poles are placed outside the bog, allowing the bog to be spanned. Access could be gained on either side of the bog, thus avoiding a wetland crossing.

For underground construction, the greatest difference in the type of equipment used is based on a variety of factors, including the need: (1) for thermal sand as backfill; (2) to transport reels of cable to the ROW (as opposed to pulling conductor from one location to another); (3) to transport splice trailers to every splice along Segment 1; and (4) to transport splice vaults to every splice location along Segment 1. I describe the logistical and environmental impacts associated with these factors and other similar factors throughout Section D of the Paquette Sur-rebuttal. If excavated material cannot be backfilled into the trench or spread in uplands along the ROW, then the increase in activity associated with material removal alone would warrant the need for additional mats because with excessive traffic, mats tend to "rock" or sink deeper into the substrate. Uplands would also need to be graded smooth and/or matted because wheeled dump trucks cannot traverse rough upland terrain and the soil may be too soft to withstand heavy-duty equipment especially during spring and fall.

With the NECEC being a major transmission line, access for repairs is an important consideration regardless of whether overhead or underground. For an overhead line, the repair process is simpler, beginning with identification of a fault or other problem. Equipment in a substation can provide a rough idea of where a fault has occurred. Once the general area is identified, a focused effort would be conducted to identify the specific issue. With the NECEC, a helicopter would likely be used for visual identification. For relatively simple emergency repairs (such as a downed tree on a line or a failed insulator), emergency response can be fast, with the outage restored within a few hours or a day. During an emergency repair, there are a number of options to access the ROW depending on the emergency and where it is located that could range from a small crew using ATVs to the use of a tracked bucket truck or excavator on a mat road.

For underground cables emergency repairs are much more complicated. Repairs are necessitated by either a cable failure (e.g., a hot spot in the cable) or a fault, where the cable or splice is damaged thus creating a pathway for electricity to surge into the ground. Equipment in a substation or converter station can detect a fault and in microseconds breakers would be opened to stop the flow of electricity. For an underground cable failure or fault, the exact location of the problem would needed to be pinpointed using an excavator, however. Similar to an overhead line, the general location of the failure or fault can be determined by equipment in the substation or converter station. However, there is no way to visually inspect the cable (using a helicopter or otherwise) without excavating. Excavating the general area of the fault must be done carefully so as to not damage the portions of the cable that are still functional. The nature of the required excavation could be considerable, taking even more time.

You can think of a cable failure or fault as a small piece of "bad wire." It cannot generally be fixed, but must be cut out, which requires splicing the two new good ends of cable together or splicing in an entirely new segment of cable. When a cable failure or fault is pinpointed, a splice trailer would need to be transported to the location. If the problem is not at an existing splice site, then a new vault would need to be transported to the new splice location and installed after further excavation. Thermal sand imported with dump trucks would need to be placed in the vault once the splice has been completed. Any impediment to quick access, such as the need to lay mats or build bridges would increase the response time and thus outage time. Therefore, to decrease the risk associated with extended outages, permanent gravel access roads should be built at a minimum to each splice vault.

<u>Environmental Questions</u>:

13. Whether taller poles and travel corridors could provide enough of a link between the habitat on both sides of the corridor for species like the pine marten.

Answer:

Because of the need to access the ROW for maintenance and emergencies, and to ensure that vegetation does not encroach into the conductor clearance zone, in my opinion it is not advisable to attempt to create travel corridors for pine marten under a transmission line. When managing for pine marten, the forest canopy height should be at least 30 ft. Unless a rigorous vegetation maintenance program is implemented that would be similar to managing a city park, it would be impossible to achieve the desired cover and structure of pine marten habitat under a transmission line. Implementing such a maintenance program itself would increase environmental impacts associated with permanent and temporary access requirements.

It has been shown that pine martens avoid clear-cuts. This is understandable given the amount of time pine martens spend in the tree canopy. However, this does not necessarily imply that pine martens would not cross a vegetated transmission line ROW with herbaceous vegetation and shrubs. Consider the following analogy to squirrels.

One can scientifically observe squirrel movements using radio telemetry, the data from which provide "snapshots" in time of the location of specimens. More snapshots of specimens in locations with habitat type A, say tree canopies, implies that squirrels as a species prefer tree canopies. Fewer snapshots of specimens in locations with habitat type B, say roads, implies that squirrels as a species avoid roads. Let's assume a statistically significant record of squirrel movements every five minutes. How many snapshots do you think would be recorded of squirrels on roads? Probabilistically, there would be very few snapshots of squirrels on roads because squirrels spend relatively little time on or crossing roads compared to being in trees or foraging under tree canopies. But it does not follow that squirrels avoid roads. We know from our everyday experience that squirrels often cross roads. If the amount of time a squirrel is observed crossing the road is proportional to the width of the road, taking into consideration the overall available squirrel habitat, then it cannot be said that squirrels avoid crossing roads, though they do prefer other habitat types.

Similarly, we cannot say that pine martens will avoid crossing transmission lines based on radio telemetry data[3] or daily observation. Pine martens certainly prefer forested habitat, but may be

[3] Continuous monitoring is now possible through satellite tracking, though I am unaware if this has or can be used to monitor pine marten.

willing, like squirrels, to frequently, though very quickly, cross a vegetated transmission corridor to get to forest habitat on the other side. Given the lack of evidence to support that pine marten will not cross vegetated ROWs, and that pine marten are legally permitted to be trapped and are not a protected species in Maine, in my opinion, there will not be a significant adverse impact to pine marten caused by the Project.

14. In TNC's nine areas of concern, whether travel corridors must be located within a certain distance of the structures (poles), and what the minimum width would be of the travel corridors in order for species like the pine marten to use them.

Answer:

In my opinion, there is no need to maintain travel corridors under an overhead transmission line. As discussed above, telemetry data in general does not necessarily support that pine martens, or other species, will totally avoid and thus not cross a transmission line ROW; the data simply mean that pine martens do not spend a lot of time in open habitat. The terms 'prefer' and 'avoid' are artificial terms used to describe the pattern exhibited by the locations of pine marten data. These terms are useful in describing pine marten movement but, again, do not necessarily describe habitat use accurately. Additionally, a ROW is a relatively narrow strip whereas a clear-cut is typically a block of land that has been cleared. It is a stretch to draw a comparison between ROW and clear-cuts.

15. In TNC's nine areas of concern, whether tapering would adequately reduce the forest fragmentation of any clearing.

Answer:

In my opinion, it is not preferable to maintain tapering under an overhead transmission line because tapering would compromise the reliability of the line and likely increase overall environmental impacts. Reliability is compromised when vegetation grows into the conductor clearance zone and creates an opportunity for electricity to arc to the vegetation and create a fault. Vegetation does not have to touch a line for a fault to occur. For the voltage of the NECEC, electricity can create an arc up to 12 to 15 feet in length. The Northeast Blackout of 2003 was caused by such an event.

Further, to create a living, forested habitat using tapering would require significant annual maintenance. If trees were simply topped to provide tapering, most of the tree crowns would be lost and the trees would die. You would be left with tapered, dead trees until younger trees grew taller. Once the younger trees grow taller, annual maintenance would require the use of bucket trucks for trimming those trees that could not be climbed by an arborist. For bucket trucks to access the ROW, a permanent road would need to be constructed or mats and bridges would need to be placed in the ROW during each access event. For standard ROW maintenance, the ROW is accessed every 5 years on average, and on foot. There is typically no need for heavy equipment to travel down the ROW.

17. Whether tapering within the 100-foot buffers around streams would provide adequate large woody vegetation for streams in segment 1 which are typically less than 10 feet wide.

In my opinion, it is not preferable to maintain continuous forested vegetation under a transmission line. The best option in this scenario, in my opinion, would be to create a narrow vegetation buffer (25 feet on either side of a stream) that allows taller vegetation to grow up to a threshold. Hand cutting would be used in the buffer and no herbicides would be allowed. Shrubs such as tall alders would be maintained as well as trees species such as balsam fir up to 10 to 12 feet. For streams less than 10 feet this type of buffer would provide adequate cover, as the streams are narrow enough to be screened by remaining vegetation.

Dated at Scarborough, Maine this 1st day of May, 2019.

By: ____________________
Gil A. Paquette

The aforenamed Gil A. Paquette did personally appear before me and made oath as to the truth of the foregoing pre-filed testimony.

Before me: ____________________
Robert B. Borowski
Attorney at Law
Bar Number: 4905