THE STATE OF NEW HAMPSHIRE

BEFORE THE

SITE EVALUATION COMMITTEE

DOCKET NO. 2015-04

PRE-FILED DIRECT TESTIMONY OF JAMES JIOTTIS

APPLICATION OF PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE D/B/A EVERSOURCE ENERGY FOR A CERTIFICATE OF SITE AND FACILITY FOR CONSTRUCTION OF A NEW 115 kV TRANSMISSION LINE

THE SEACOAST RELIABILITY PROJECT

April 12, 2016

<u>Qualifications and Purpose of Testimony</u>

Q. Please state your name, title, and business address.

A. My name is James J. Jiottis. I am a Project Manager – Transmission Siting at Public Service Company of New Hampshire d/b/a Eversource Energy ("PSNH"). My business address is 780 North Commercial Street, Manchester, NH 03106.

Q. Briefly summarize your educational background and work experience.

A. I hold an Associate's Degree, in Industrial Electricity from New Hampshire Technical College, a Bachelor of Science in Electrical Engineering Technology from Northeastern University, and a Master of Business Administration from Suffolk University. I have over 30 years of experience in the electric utility and utility related industry. I have been involved with leadership and technical responsibilities in the areas of engineering, transmission operations and maintenance. Please see Attachment A for my resume.

Q. Have you previously testified before the Site Evaluation Committee?

A. No, I have not.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to describe the preferred route for the Seacoast Reliability Project ("SRP" or the "Project") and any other route alternatives that PSNH analyzed. I will also describe the property rights associated with the Project, the Project design and the alterations proposed by PSNH to avoid and minimize potential impacts to aesthetics, historic resources and the environment all in accordance with Good Utility Practice and as constrained by PSNH's property rights. Lastly, I will discuss whether the Project will generate any audible noise.

Q. What is your role in the Project?

A. I am responsible for overseeing all technical aspects of the Project.

Q. Please describe "Good Utility Practice."

A. The concept of Good Utility Practice generally refers to a project being designed, constructed, installed, operated, and maintained in accordance with the National Electrical Safety Code and guidelines and standards issued by the Independent System Operator of the New England electric system ("ISO-NE"). This is also consistent with the Administrative Rules that govern the New Hampshire Public Utilities Commission. Written by the Institute of Electrical and Electronics Engineers, the National Electrical Safety Code C2-2012 ("NESC") contains the standard industry guidelines and safeguards that apply to the construction, operation, and maintenance of electrical transmission lines to ensure the safety of employees and the public. In general, all electric supply lines, including transmission lines, must be designed, constructed, operated, and maintained to meet the requirements of the specifications found in the NESC. All utilities must conform to and meet the applicable requirements.

According to ISO-NE guidelines, and the *ISO New England, Inc. Transmission Markets, and Services Tariff,* "'Good Utility Practice' means any of the practices, methods and acts engaged in or approved by a significant portion of the electric utility industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather includes all acceptable practices, methods, or acts generally accepted in the region, including those practices required by Federal Power Act Section 215(a)(4)." The Federal Energy Regulatory Commission has also adopted a similar definition in the Pro Forma Access Open Transmission Agreement, § 1.14 and adopted through FERC Order 888.

Importantly, Good Utility Practice is intended to create the best overall solution taking into account all design and construction criteria. As a responsible utility, PSNH is dedicated to following Good Utility Practice throughout each stage of all of its projects. Not only does PSNH follow utility practices that are considered standard across the industry, PSNH optimizes the design of its projects to reach the desired results, while simultaneously expending only those costs that are reasonable.

PSNH's practices are also consistent with New Hampshire Public Utilities Commission ("NHPUC") rules, which requires utilities to construct, install, operate and maintain equipment and lines after considering numerous factors, including, how to best accommodate the public, cost, safety, in service requirements, and to prevent interference with other utility infrastructure.

Property Rights

Q. Please describe whether the Applicant has a current right, an option, or other legal basis to acquire the right, to construct, operate, and maintain the facility on, over, or under the site.

A. PSNH currently owns, or has the legal rights secured, for all of the property or the property rights necessary to construct the entire Project as proposed in the Application.

Portions of the Project not situated within or across public roadways, or across public waters or State owned lands, will be sited in existing PSNH right- of- way ("ROW") between the Madbury Substation in Madbury, New Hampshire and Portsmouth Substation in Portsmouth, New Hampshire. The PSNH ROW to be used for the Project is comprised of either land parcels, which the Applicant owns in fee ownership, or real estate rights and interests comprised of various licenses and permanent easements owned or under contract by the Applicant for the purposes of the construction, operation and maintenance of electric power lines. I have consulted with and been informed by its Real Estate Department that PSNH has the current right, either because of its land ownership, under current agreement/contract, or under its existing easements which it already owns, to construct, operate and maintain the Project and its components within and along the ROW owned and managed by the Applicant in the Towns of Madbury, Durham, Newington and the City of Portsmouth.

Q. Please address the requirement in recently adopted Site 301.03 (c) (7) that the Application contains evidence that the Applicant has a current or conditional right of access to private property within the boundaries of the proposed energy facility site sufficient to accommodate a site visit by the Committee.

A. Unlike a power generator, wind turbine facility or other similar energy facility located on a discrete private property site, the majority of the Project is proposed to be sited within and along a 12.9 mile ROW owned or licensed by PSNH situated in three towns and one city in NH, and already occupied by electric power distribution and/or transmission lines owned and operated by the Applicant. These ROWs are regularly accessed by the Applicant and their contractors in connection with the operation and maintenance of their existing power line facilities. The combination of land parcels owned or under contract by the Applicant, and numerous public access points (roadways and public land locations) on, within or adjacent to the ROW to be used for the Project, will supply more than adequate and sufficient access to accommodate a site visit by the committee to view the proposed Project site. Therefore, the Applicant does not need to secure additional property rights to allow Committee members to visit the site of the Project.

Routing Study and Alternatives Analysis

Q. Briefly describe the project selection process.

A. ISO-NE identified a geographic area of the electric system, defined as the “New Hampshire Seacoast Region” that is in need of additional generation resources or transmission capacity to serve the existing 115 kV system during certain operating conditions. As discussed more fully in the pre-filed testimony of Robert Andrew, the Seacoast Region must address violations of thermal and voltage transmission planning criteria, which are more significant when generation connected to the 115 kV transmission system or existing transmission facilities are unavailable. As a result of the need and in accordance with ISO-NE process, PSNH and other members of an ISO-NE working group presented solutions to the ISO-NE Planning Advisory Committee (PAC). The most cost-effective remedy to resolve the needs of the Region was chosen and approved by ISO-NE, namely, the Seacoast Solution suite of projects. The Seacoast Solution suite of projects includes more than 10 different discrete projects, including the construction of the Project.

Once it was determined that the Seacoast Region faces thermal and voltage criteria violations that could lead to equipment damage, power outages, and public safety concerns, the ISO-NE working group undertook a thorough study and evaluation process to identify the solution that addressed the needs in a cost-effective and viable manner. The preferred solution was determined based upon numerous factors ranging from costs, to operational performance, to constructability issues.

Q. Please describe the route selection process.

A. After the Seacoast Solution suite of projects, including SRP, was identified as a preferred solution, PSNH conducted an analysis of potential routes from the Madbury Substation to the Portsmouth Substation. To determine the optimal route for the new transmission line, PSNH reviewed available Geographic Information System (GIS) data to identify potential route options. The study area included the Lee, New Hampshire area to the west, the Dover, New Hampshire and Eliot, Maine area to the north, the New Castle, New Hampshire and Kittery, Maine area to the east, and the Stratham, New Hampshire area to the south. Route locations beyond these general limits were not evaluated because any resulting route options would have been significantly longer and resulted in greater impacts and higher costs, while not providing the necessary electrical solutions that the Project was designed to meet. *See* Section 301.03 (h)(2) of the Application for detailed information on route selection.

Q. Please describe the factors that PSNH considered when determining the preferred route?

A. Once the Seacoast Solution was selected, PSNH undertook a route selection process, which looked at numerous factors to decide upon the optimal route. The route selection objectives were to: (1) maximize the use of existing linear corridors (including the potential to co-locate within or along roads, railroad corridors, and existing natural gas pipeline corridors); (2) minimize the need to acquire new land or land rights; (3) minimize and avoid adverse impacts to environmental resources and limit permitting complexity to the extent practicable; (4) maximize electrical reliability by correcting the identified voltage concerns at a reasonable cost and at the same time not causing additional voltage concerns that would require additional system fixes elsewhere; (5) maximizing system operability while limiting maintenance activities associated with the line; (6) minimizing cost; and (7) develop a route that would meet ISO-NE's preferred in-service date.

PSNH reviewed each objective and sought to develop a project that would successfully address the reliability concerns identified by the New Hampshire/Vermont Transmission Study Needs Assessment ("Needs Assessment"). Cost-effective routes are preferred to minimize the burden on customers to the extent practicable. Less impactful routes are preferred to minimize the impact on customers and environmental or cultural resources. At the same time, the preferred route must ensure that the regional electric system meets the identified need.

Q. What route alternatives did PSNH analyze as part of the routing analysis?

A. PSNH analyzed three route alternatives, which were divided into geographic groupings: the Northern Route Alternative, the Middle Route Alternative, and the Southern Route Alternative.

Ultimately, the Middle Route Alternative was selected as the route because it was almost exclusively within an existing PSNH utility corridor, it did not require the purchase of any additional easements or property, it would result in fewer impacts to wetlands and other natural and cultural resource areas, it could be built within the desired schedule, and it is the least cost alternative.

Q. Please describe the three route alternatives that were analyzed.

A. PSNH evaluated the three potential alternatives against the seven objectives discussed above.

The Northern Route Alternative would have utilized existing transmission corridors that travel east from Madbury, New Hampshire into Eliot, Maine, turn to head southeast to Kittery, Maine and then return into Portsmouth, New Hampshire.

The Southern Route Alternative would be a longer route that would have utilized an existing railroad corridor and the existing utility corridors. Part of this route would have utilized a ROW and rail corridor also considered for the Middle Route; however, it would have also utilized additional ROW. This route would have traveled south from Madbury until it reached Stratham, New Hampshire where the line would head east into Greenland, New Hampshire, and eventually turn north into Portsmouth.

The selected route, the Middle Route Alternative, is the shortest alternative and uses existing rail corridors, existing PSNH utility corridors that contain existing distribution and/or transmission lines, an existing underwater utility cable corridor through Little Bay that has been in-place since 1902, and underground through sections of municipally maintained roads all the way from Madbury Substation to Portsmouth Substation. No additional easements or fee purchases were required.

Q. Please explain how PSNH determined that the Northern and Southern Routes were not available.

A. Both the Northern and Southern Route Alternatives presented significant constructability, permitting, land rights, and cost issues and, therefore, were not considered viable as potential routes.

In particular, the Northern Route Alternative presented several challenges in technical, cost, and siting areas. Most notably, to construct the Project, the existing transmission lines in the Northern Route corridors would have to be relocated and rebuilt within the corridor to make room for the new line. The existing transmission lines would need to have been removed from service for extended periods of time to facilitate this relocation. Removal of any transmission facility from service, planned or unplanned, can strain the remaining in-service transmission elements. Typically, planned requests to remove equipment from service are submitted up to 12 months in advance. Even with the long term scheduling, requests may be cancelled due to system requirements. To allow these requests, ISO-NE must study the projected system conditions and dispatch the system generation to maintain system reliability with the requested transmission out of service. This system “posturing” may involve limiting generation, running generation out of economic merit order, and requiring the work to be performed outside normal business hours and during specific seasons. These potential restrictions add costs to a project and to the customers in New England who would pay for these added costs. To complete the required relocations, outage durations between several weeks and several months would be required. These outages would have presented risks to the electric system in New England. Construction of the Project would have required rebuilding the existing lines. The additional construction needed to relocate and rebuild the existing lines would add significant costs to the project.

In addition, the Northern Route Alternative would have been complicated by the need to acquire new easements and additional land rights in the State of Maine. The Northern Route was ultimately not considered available because portions of the existing transmission corridor in Eliot and Kittery would have required expansion and/or the acquisition of underground rights to support two Piscataqua River Crossings. Crossing the Piscataqua River twice also presented significant technical challenges for both the underground/underwater and overhead crossing. Moreover, the Northern Route would have required increased permitting and siting in both the State of New Hampshire and the State of Maine, which would likely have impacted the in-service date.

Therefore, due to the in-service schedule risks, additional complexity associated with obtaining permits and approvals in two states in a timely fashion, system impacts due to construction outages, added cost to relocate existing lines and the availability of other more attractive route options, the Northern Route Alternative was eliminated from further consideration.

Similarly, the Southern Route Alternative was not considered viable due to numerous technical challenges, cost issues, and environmental concerns. The Southern Route was also rejected because the route would potentially create more voltage and reliability issues than it would solve. The Southern Route was almost twice the length of the other route alternatives, which would not on its own, have solved all the voltage issues identified in the Needs Assessment. The Southern Route would have also required the construction of additional infrastructure to fully address the voltage criteria. Moreover, siting a line routed to the south of the Project area would result in the siting of the new 115 kV circuit farther from the end point connections (i.e., the Madbury and Portsmouth Substations). The additional infrastructure required to address the voltage concerns and the increased line length would significantly increase the cost of the Project.

The Southern Route also posed significant technical challenges, including the proposed corridor runs through the Portsmouth traffic circle where the existing corridor does not have space for a new transmission circuit. Therefore, underground transmission cables would have been required through this area; and PSNH would need to secure additional land rights to construct the Project. The use of underground cable, lack of existing underground rights across the Portsmouth traffic circle area, and the increased complexity for cable installation (within or along the interstate highway right-of-way) added to the cost of the Southern Route. Lastly, the Southern Route presented greater environmental impacts to wetlands and State-designated prime wetlands in the southern sections of the State.

Q. Please explain why PSNH Middle Route Alternative is the only available route.

A. The Middle Route Alternative was clearly the optimal and only available choice. As previously stated, the Middle Route is the shortest route and is fully contained in existing linear corridors. This route did not require new easements or additional fee property and has the least impact on the environment. It is also the lowest cost alternative and the simplest to construct. As a result, it is the most economically, environmentally and technically attractive alternative to meet the system needs.

Q. Within the selected route, what route variants did PSNH analyze?

A. Once the route was chosen, PSNH underwent a further analysis of route variations within the selected route. PSNH again considered the same seven objectives described above to choose the optimal route for the new transmission line.

For a majority of the route, route variations were not available for consideration because only one corridor exists to reach the pre-existing cable crossing of Little Bay. In fact, the selected route from Madbury Substation south to Packers Falls Substation and east to Little Bay was the only option available to reach the western shore of Little Bay.

Alternate locations for crossing Little Bay were reviewed. In each case, no other utility corridor exists to link any other crossing with the Project route. The use of another crossing location would have required the acquisition of new property rights and the creation of new utility corridor. These alternative crossings were not considered further due to the need to acquire additional rights across Little Bay.

After crossing Little Bay underwater, PSNH then evaluated three possible route variations in consultation with the Town of Newington. This evaluation resulted in: (1) a route that travels underground in the public road through Gundalow Landing Circle until reaching a transition structure that would be located on the easterly side of Little Bay Road, and then continuing overhead in the existing ROW until the Spaulding turnpike; (2) a route variation that makes landfall from Little Bay south of Gundalow Landing Circle and travels underground through the northern side of Great Bay National Wildlife Refuge ("Wildlife Refuge") and underground alongside Arboretum road until it transitions to overhead on the eastern side of Portsmouth International Airport at Pease; or (3) a route that travels underground through Gundalow Landing Circle, Little Bay

Road, and Arboretum drive until it transitions to overhead on the eastern side of Portsmouth International Airport at Pease. The second and third options were suggested by the town of Newington as alternatives. *See* Appendix 24, *Town of Newington Suggested Alternative Routes*

In addition to these route variations, numerous minor variations within each route were examined. As an example, the route through the Pease Tradeport included such alternates as multiple underground paths through the Wildlife Refuge, various routes along Arboretum Drive, various routes cutting through Pease International Airport and inclusion of overhead sections through Pease Tradeport. The variations were considered in consultation with the Town of Newington and received feedback as a result of public presentations to the town of Newington.

Q. How did PSNH select its final route?

A. As part of the route variation analysis, PSNH discussed the proposed Project with local officials, the Federal Aviation Administration (FAA), the Pease Development Authority, and the Great Bay Wildlife Refuge. As a result of these discussions, and following a thorough analysis consistent with Good Utility Practice, PSNH ultimately determined that the route variation that travels underground through Gundalow Landing until it transitions to overhead at a transition structure on the easterly side of Little Bay Road, continuing within existing utility ROW to the Spaulding Turnpike, (a.k.a. Route Variation 1), was the only viable route.

Q. Please explain why PSNH adopted Route Variation 1.

A. PSNH first contacted the FAA to discuss Route Variation 1. For this alternative, PSNH already had all of the necessary property rights to construct the Project, including the underground section through public roads in the Gundalow Landing neighborhood.

PSNH also confirmed that the Project overhead design, sited to the north of the Portsmouth International Airport at Pease, would meet all FAA height requirements that are applicable to utility structures and glide paths for aircraft approaching and leaving the airport. The FAA reviewed the Project structure heights proposed at this location and did not identify any issues that would have changed the Project’s design and also determined that the Project would meet all applicable FAA standards. Prior to filing an application with the FAA, PSNH met again on November 25, 2014 with local FAA representatives, the Air National Guard, and the Pease Development Authority, which confirmed that there were not any issues of concern with the Project. Based on the results of this meeting, PSNH submitted the required applications to the FAA to receive a Determination of No Hazard to Air Navigation. The FAA determination confirmed that the proposed route would not have any effects on local air traffic; therefore, there is no FAA requirement or technical reason for the Project to be constructed underground.

Q. Please describe how PSNH analyzed Route Variation 2.

A. PSNH consulted with the Great Bay National Wildlife Refuge regarding Route Variation 2. Most importantly, Route Variation 2 would require that sections of the Wildlife Refuge be impacted or permanently converted to transmission ROW. As the Wildlife Refuge is physically closer to the Pease runway, an overhead design though this area would not have been practical as it was likely that an overhead design would be considered a hazard to air navigation. The construction of an underground line would have resulted in an impact to approximately 2,200 ft. of the Refuge; including trees and forested wetlands that would have to be altered and / or cut to bury this portion of the line. Wildlife Refuge personnel informed PSNH that the Refuge is focused on the restoration of bat habitat, which means preserving forested lands or lands that primarily consists of trees. Based on the potential impacts to the Wildlife Refuge associated with installing the transmission cable underground, the Wildlife Refuge indicated that it would not support the Project. *See* Attachment B (correspondence from the Wildlife Refuge). Going through the Wildlife Refuge would also likely trigger review under the National Environmental Policy Act (NEPA), which would impact the Project schedule.

The Town of Newington also contacted the Wildlife Refuge and its regional management and requested that the Wildlife Refuge grant PSNH permission to traverse the refuge with a transmission line. The Wildlife Refuge repeated its concerns to the town and stated it would not support a transmission line (overhead or underground) through the Wildlife Refuge. *See* Attachment C, Newington Town Minutes re: discussion with the Wildlife Refuge.

Moreover, Route Variation 2 would have also required the line to travel underground from the easterly boundary of the Wildlife Refuge, along Arboretum Drive, to a point on the eastern side of the Pease Runway due to the very close proximity of the Pease runway. This routing would also have required the underground line to pass through a United States. Environmental Protection Agency ("EPA") designated Superfund site on the Pease property, specifically Site 8, Fire Department Training Area 2, AT008, DES Site # 100330508. Placing an underground line through this Superfund site would certainly increase Project costs and create additional environmental risks to the surrounding area and, potentially, to installation personnel, and PSNH employees.

Route Variation 2 also relied on locating any underground cable or overhead line in and along Arboretum Drive. Most of Arboretum Drive in this section is encumbered with an easement for the Portland Natural Gas Transmission System high pressure natural gas line which runs along and under Arboretum Drive. PSNH consulted with Portland Natural Gas about the placement of an underground high voltage transmission line near the gas line. Portland Natural Gas does not allow underground high voltage lines that run parallel to the gas line within its easements. Therefore, the Project would have had to site the transmission line along Arboretum Drive, outside the Portland Natural Gas Transmission System easement, which would require the creation of a new ROW adjacent to the drive. Creation of this new ROW would have necessitated travelling through, and clearing portions within the Newington Town Forest and the Newington Center Historic District.

The Town of Newington suggested additional variations of this route including the creation of an underground route along the perimeter of the north end of Pease runway and creating a new ROW through currently forested property on the east side of the Pease runway. Both variations, however, must still address the same issues with traversing through the Wildlife Refuge and EPA Superfund site.

Utilizing a route on the Wildlife Refuge and Pease property would also have required a shift in the underwater crossing of Little Bay. This would have placed the cable outside its historic and currently mapped cable crossing and would have also lengthened the underwater crossing.

PSNH would also be required to purchase land rights from the Wildlife National Refuge and from the Pease Development Authority. Route Variation 2 would have ultimately created a new utility corridor. In consideration of these factors, the lack of support from the Wildlife Refuge, and the determination that there were no technical reasons to site the Project underground, Route Variation 2 was not considered a viable alternative.

Q. Please describe how PSNH analyzed Route Variation 3.

A. Route Variation 3 would require additional portions of the line to be buried within municipal roads through the town of Newington, which presents significant engineering design complications and would dramatically increase the cost of the Project.

Route Variation 3 would require the new transmission line to be constructed within Little Bay Road and McIntyre Road, after leaving Gundalow Landing. These roads would be used to connect with Arboretum Drive on Pease Tradeport. An underground design along these roads would not be able to remain in the road ROWs and would be extremely disruptive to residents not presently impacted by the existing utility ROW. Siting the line underground along Little Bay Road, McIntyre Road, and Arboretum drive would also require purchasing additional property rights from the Newington residents and the Pease Development Authority. Route Variation 3 would also require crossing of the EPA Superfund site. Based on the additional distance of underground required for this option (approximately 1.5 miles), the corresponding costs, the need for additional land rights, and the fact that there was no technical reason to site the project underground, Route Variation 3 was also considered not to be a viable alternative.

PSNH also met with members of the Pease Development Authority on June 5, 2014 to discuss the possibility of siting the transmission line through Pease property along Arboretum Drive. The Pease Development Authority felt the line could be built on Pease property; however, they explained the potential challenges this type of project would need to address. Specifically, issues with soil contamination, wetlands and issues related to working at the end of the runway were discussed. The Pease team determined that the majority of the line would need to be underground given its proximity to the runway. The Pease Development Authority would support the construction of an underground line along Arboretum Drive as long as the following issues are addressed in the design: concerns related to the nearby Superfund hazardous waste site, approval of the Project by the FAA and Air National Guard, PSNH would need to purchase easement rights and the Project would need to receive final approval from the Pease Development Board of Directors.

However, after evaluating the issues attendant with each of these alternatives, PSNH determined that Route Variation 1 was on balance, the only route available that met the routing objectives.

Q. Does the decision to go underground in two separate segments affect the Project's preferred route?

A. No. The increased use of an underground/underwater design allows for a reliable and cost-effective design, when compared to other alternatives. While the additional underground segments increase the estimated cost of the Project, it is still less than the alternatives and consistent with Good Utility Practice.

Overview of Project Design

Q. Please provide a general overview of the Project design.

A. Consistent with Good Utility Practice and in consultation with the host communities, the Project has made significant modifications to the design of the Project, including the use of underground construction.

The Project is a 115 kV transmission line (designated Line F107) that will run approximately 12.9 miles from an existing 115 kV terminal position at Madbury Substation in Madbury, NH to a proposed new 115 kV terminal at Portsmouth Substation in Portsmouth, NH, and includes the relocation of an existing transmission line (the E194 line) and the removal and relocation of existing distribution lines to provide adequate space within the existing corridor.

The overhead portion of the Project will be constructed predominantly on single pole structures, with other structure designs used in certain locations to avoid and minimize potential visibility. The overhead construction will be configured as either single circuit 115 kV structures with the existing 34.5 kV distribution circuit located adjacent on the same ROW, or combined on the same structure as a "double circuit" with the existing 34.5 kV distribution line. The conductors on these structures will be configured either vertically with all three 115 kV conductors on the same side of the pole ("phase-over- phase") or with two wires on one side and one on the other ("delta"). Where double circuited, the 34.5 kV distribution circuit will be supported underneath the

115 kV line in a horizontal configuration. Specific details of conductor type and size is described in section 301.03 (h)(1) of the Application.

Approximately 1.8 miles of the Project will require submarine and underground cable construction. Traveling from west to east, there is an underground section crossing Main Street in Durham, followed by the underwater crossing of Little Bay from Durham to Newington. Finally, there is a section of cable where the submarine cable converts to underground construction as it leaves Little Bay in Newington and travels to a structure where the line transitions from underground to overhead.

The Project requires transition structures to facilitate the change from overhead conductor to underground or submarine cable when crossing Main Street in Durham, on the western side of Little Bay in Durham, and again on the eastern side of Little Bay at Little Bay Road in Newington.

To the west of Spaulding Turnpike, the majority of the Project will be constructed in an existing ROW that is already occupied by existing 34.5 kV distribution lines. The line will run in a southerly direction from Madbury Substation in Madbury to Packers Falls Substation in Durham and in an easterly direction from Packers Falls Substation to the west side of Little Bay. On the east side of Little Bay in Newington, the Project continues in an easterly direction in an existing distribution corridor to the proposed crossing of the Spaulding Turnpike in Portsmouth.

Q. Describe the design process and the major factors that were considered.

A. After the required line voltage, power flow requirements, and terminal points were determined, and the preferred route was developed based upon Good Utility Practice and the routing objectives and evaluating criteria

The preliminary design process consisted of conductor selection, consideration of available or necessary real estate rights, evaluation and selection of structure configurations, gathering of field survey information, conducting wetland delineations, researching other environmental resource constraints, and evaluation of aesthetics and potential cultural resource impacts

The engineering design team used transmission modeling software along with a three-dimensional survey of the ROW to design the Project. The Project is designed to meet all Eversource and NESC standards to ensure safe and reliable operation. Additional information that includes, but is not limited to, environmental resources, aesthetics and potential impacts to cultural (archeological and historical resources), the historic ROW boundary survey, soil conditions, aerial imagery were incorporated to refine the design. The Project is designed to reduce potential visual and environmental impacts to the greatest extent possible as constrained by existing property rights, existing infrastructure and geography.

The line layout was finalized, keeping the new line sufficiently within the existing ROW limits while meeting Eversource and national design standards, and also minimizing impacts to environmentally sensitive areas and visibility to nearby landowners.

Q. Please describe the types of structures the Project chose for overhead lines and how they were chosen.

A. A variety of structure types will be used to construct the Project. The majority of the structures will be single pole structures (monopoles). Most of the monopoles will be double circuit structures, which also support an existing 34.5 kV line beneath the 115 kV conductors. Some will be single circuit structures which support only the 115 kV line. These structures will have a few different configurations. The Project will also use some H-frame type structures, which consist of two poles with a horizontal crossarm. These structures are generally shorter in height; however, they require a wider footprint which makes them unsuitable for most areas of the Project. *See* Section 301.03 (h)(1) for a more detailed discussion of the structures in each segment and Appendix 5 (Structure Type Index of the Engineering Design Drawings) for the general arrangements of all structures proposed for this project.

The selection of structure types in a particular location are based on technical requirements, such as ROW width, span lengths, conductor size and clearance requirements. Structure designs were also selected after input from stakeholders and to avoid or minimize potential impacts to aesthetics, cultural and historical resources and the environment.

Q. Please describe the design of the underground segments.

A. The underground cable system itself will consist of three cables. Each cable will be comprised of a 3,500 kcmil copper conductor with solid dielectric (cross-linked polyethylene) insulation plus two runs of fiber optic cable. The underground cables will be installed in conduit encased in thermal sand and/or concrete. The conduit system was selected since it provides mechanical protection to the cable system from third party damage and provides an opportunity to access and, if necessary, replace the cable without re-excavating the entire route. For additional information on the design of the underground segments please *see* Section 301.03 (h)(1) of the Application.

Burial depth will be increased from approximately 3.5 feet to 8 feet through sections of the underground line on the University of New Hampshire ("UNH") campus to avoid existing facilities and allow for future roadway designs provided by as the UNH Facilities group. The section of underground transmission line passing through UNH parking lot A will be designed to allow vehicle traffic to pass over it. This will allow continued use of the ROW as parking area for UNH.

Where the section of underground line passes below Main Street in Durham, a pipe jacking system will be utilized. This will allow the line to be built without construction occurring in the roadway or disrupting the normal traffic flow. Pipe jacking is a method of horizontal boring construction, which places a casing under the road. The conduits will subsequently be placed within the casing. During the pipe jacking construction, additional conduits will be installed for future use. PSNH's proposal will not interfere with the safe, free, and convenient use for public travel of the locally-maintained highways.

Transitions between overhead and underground cable will occur on steel pole riser structures (will be referred to as transition structures in Project documents). The cable will rise along the outside of the structure to terminator facilities mounted on steel arms at certain elevations above ground to comply with NESC and PSNH standards. Cables along the outside of the structure will be protected by the use of rigid steel conduit.

The submarine cable will transition to underground cable in a manhole. The line will then exit the manhole on an easement held by PSNH and follow Gundalow Landing road across Little Bay Road. The section of underground cable and conduit along

Gundalow Landing road in Newington will be placed within the road ROW at similar depths and using similar construction as in Durham.

At the east of Little Bay Road, the cable will transition to an overhead design adjacent to the existing electric ROW corridor. The transition from underground to overhead will utilize a specially designed transition structures consisting of three single pole, self-supporting steel requiring foundations; each phase will attach to one pole. Use of a three pole structure allows the overall structure height to be lower. From the transition structure, the Project will travel overhead within the existing ROW corridor to the Spaulding turnpike.

Q. Please describe the segment of the Project that will be constructed underwater.

A. Due to distance and topography it was impractical to aerially span the entire width of Little Bay. As a result, an underwater segment will cross Little Bay in an existing charted Cable Area, a corridor historically defined as containing underwater power cables and which currently contain sections of de-energized cables. The overhead design on the Durham side of Little Bay will transition to a short section of approximately 360 feet of underwater cable installed on the land. The transition between overhead and underwater cable will occur at a single steel pole structure. These cables will be installed within a concrete duct back and travel from the transition structure to the western shore of Little Bay. The underwater segment proceeds southeasterly across Little Bay to a precast manhole located in the existing ROW on the eastern shore of Little Bay in Newington.

The underwater segment is approximately 5,750 feet in length. Please see pre-filed testimony of Anthony Troy Godfrey for additional information. The crossing of Little Bay will utilize a specially designed armored submarine cable, placed under the sea bed.

Q. Please describe the submarine cable crossing in detail.

A. A submarine cable system is similar to an electric cable system installed on land. Both cables utilize the same materials and construction for the conductor, insulation and cable shield. The submarine cable system is designed as a high voltage, extruded dielectric (HVED) cable utilizing cross-linked polyethylene (XLPE) insulation.

The underwater section will include two fiber optic cables, which will be used by PSNH for the protection and communication between its facilities. The major difference between an underwater cable and a land cable is the cable armor required for an underwater cable. The armor provides tensile strength that allows the cable to be suspended from the installation vessel (barge or ship) to the bottom of the water body. The armor wires can be made from several different types of metal including steel and copper.

Another factor of the underwater cable design is the location of the Project and transportation of the cable to the Project site. The entire length of each individual cable (approximately 1.1 mile) will be transported to the Project site on the barge as a single length of cable. The barge must be able to cross underneath the General Sullivan Bridge (Route 4 / Spaulding Turnpike Bridge), which only allows for approximately a thirty foot clearance. This clearance limits the size and type of barge that can be used for the Project. The limitations of the barge result in a design utilizing three single cables (one cable per phase) versus one cable with all three phases in a common bundle.

Ampacity limits for underwater cables take into account several factors. The shore ends of the underwater crossing are often the limiting section for the cable system and need to be analyzed separately. This is due to higher soil resistivity and often greater depth of burial involved transitioning from the marine to land route. These considerations often result in a larger conductor size than would normally be chosen if only the water based portion of the route was analyzed.

The design of the underwater segment required an investigation into the soil conditions and tidal forces that the cable would be exposed to during its service life. The cables can be either directly laid onto the bay floor or buried into the soft sediments. In the main channel of Little Bay, there is a significant tidal flow that causes repetitive scouring of the bay floor. This scouring will cause the cables to move along the bay floor over time and could result in damage to the cables. For protection, the cables will be embedded into the sediment at a depth of approximately eight feet. In the western flats of the bay, the tidal forces are not as severe and the cable depth will be decreased to approximately three and a half feet. Deeper burial of the cables provides additional protection but also can decrease the available capacity of the cable system. If the Project cannot maintain the required depth due to the presence of ledge or other obstructions, concrete mattresses will be used to protect the cables.

Spacing of the submarine cables is an important consideration when designing an underwater cable system. To prevent inadvertently striking a previously laid cable during subsequent hydro-plow operations, the cables need to be separated by a sufficient horizontal distance. This separation allows the placement of any anchors used for the installation or alignment adjustments required due to unforeseen soil obstructions (rocks). Sufficient separation is also necessary for any future repair of the cable.

Q. What alternative methods were considered for crossing Little Bay?

A. Several variations for crossing Little Bay were considered. Early in the process, the possibility of an overhead crossing was reviewed. This would have required towers in excess of 800 feet or the creation of manmade islands in the bay to the support structures. Neither of these options was determined to be feasible, which resulted in the selection of an underwater crossing.

Two types of construction were then considered for the underwater crossing of Little Bay; direct burial via a jet plow or utilization of horizontal directional drilling (HDD). Directional boring is commonly referred to as HDD, which is a steerable trenchless method of installing underground pipes, conduits and cables in a shallow arc along a prescribed bore path by using a surface-launched drilling rig. Firms familiar with both construction methods were retained to analyze the construction methods for this potential alternative.

The HDD method would have required drilling for a distance exceeding 6,000 feet with a bore diameter of over 40 inches. While HDD was determined to be technically feasible, it presented significant challenges. The bedrock under the bay is classified as portions of the Kittery and Eliot formations that contain quartzite rock with known compressive strengths up to 30,000 pounds per square inch ("psi"). The drilling process would have required drill units be placed on the east and west shores, drilling 24 hours a day for a period of three to six months to complete the drill. Use of HDD also requires large quantities of a bentonite (clay) slurry which is used to coat and lubricate the drilled shaft. While the material is inert, containment procedures are required to prevent its spilling into the surrounding environment. The containment would have required large pools be established on both sides of the bay during the drill.

A review of the geologic structure indicated the potential for fault lines in the bed rock under the bay. Drilling through the fault lines increases the possibility of the bore "fracking out," which could release the bentonite slurry across the bottom of the bay coating the sea floor.

An HDD drill for electric cable requires the bore be sleeved with a plastic pipe. This pipe must be constructed outside the bore and pulled through as a solid piece. Assembly of the PVC sleeve would have required a setup area over 6,000 feet long. Moreover, HDD would have required large set-up areas on both sides of the bay for puling and staging cable reels.

While HDD is generally a technically feasible method for installation of an underground or submarine cable, HDD was not selected for this Project because of the potential for severe disturbance to residences and town roads on either side of the bay and the potential for an environmental incident in and along the bay.

The use of a direct burial via jet plow technology was selected. See testimony of Anthony Troy Godfrey for details on the process.

Optimization of Project Design and Collaboration with Host Communities

Q. With respect to the selected route, how did PSNH optimize the design to minimize impacts?

A. Once the route was identified, the Project design was further optimized against the seven selection criteria and also included technical considerations associated with more detailed engineering and input from stakeholders.

The structure height, type and specific locations were optimized to reduce potential impacts to aesthetics, above and belowground cultural resources, wetlands and other environmentally sensitive areas. Where possible, environmentally sensitive areas were spanned such that no disturbance is required and structures were also shifted outside environmentally sensitive areas, where possible. Construction access points were also identified such that activities during construction would minimize the need to impact sensitive areas.

The structure color along the route was optimized to blend in with surroundings or mimic existing features. The majority of the line will utilize structures with a weathering steel finish, mimicking the color of wood structures or surrounding trees. In a few selected areas, a galvanized steel structure may be used as it blends into the background (open sky) better than a weathering steel finish.

PSNH met with abutters along the proposed route and discussed planned structure locations. Minor shifts along the centerline were made to respond to landowners' specific requests. These shifts were generally limited between five to fifty feet and did not result in new environmental impacts, and were intended to mitigate some visual concerns of the abutters.

In the case of the shared corridor with the railroad, specific structure types were used to maintain required code and railroad clearances. PSNH also worked with the railroad to ensure its design will not adversely affect railroad signals.

The majority of the corridor will utilize a double circuit structure design, which consists of a single monopole that supports the existing distribution line and the new transmission line. This design makes efficient use of the corridor by reducing the amount of structures and also minimizing impacts to the corridor.

In Madbury and Durham, from Madbury Substation to UNH parking area A Lot, PSNH purchased additional ROW and property that eliminated the need to use a special design configuration in the railroad corridor. The additional ROW also allows Eversource to use fewer structures and to lower structure heights on the 115 kV line.

On the Durham side of Little Bay, PSNH's easements initially only allowed for overhead construction. PSNH secured new land rights in order to locate the transition structure further away from Great Bay to avoid and minimize potential views of the Project.

Q. After the preliminary design was complete, were there any modifications made to the Project?

A. With a preliminary design in hand, PSNH reached out to the host communities and abutting landowners, and other stakeholders for feedback. The final layout of the Project considers and includes design modifications to address specific issues and concerns raised by the municipalities or abutters and deemed consistent with Good Utility Practice and the property rights PSNH owns.

Q. What modifications and optimizations were made based on discussions with town officials and landowners?

A. In the course of working with municipalities, the main issues that arose largely dealt with minimizing views of the line. Municipalities primarily requested that PSNH locate the new structures out of the general view and secondly requested that PSNH lower the new structures to the greatest extent possible. PSNH engineers worked with abutters on a case-by-case basis to try to minimize visibility of the structures on their particular properties.

Based on comments received from public open houses and follow-up discussions with the municipalities and direct abutters, the engineering, outreach and environmental teams discussed and selected structure locations that were considered to be less impactful to abutters. Where structures could not be moved, the Project team explained why structures were originally positioned in a particular location and the importance of that specific location. The Project engineering team reviewed each structure location raised by an abutter to determine if it could be shifted or modified to accommodate the abutter's request. Generally structure moves involve sliding structures between five and fifty feet along the centerline of construction, though some minor lateral shifts are possible. The final results were/are shared with the abutter and any additional comments are taken into account. This is an on-going and iterative process between all the parties to determine structure locations that best accommodate the landowner requests while maintaining compliance with code requirements and following Good Utility Practice.

Q. How did PSNH collaborate with the Town of Madbury and optimize the Project design?

A. The existing ROW from Madbury Substation to the Durham town line, which is adjacent to the existing PanAm railway corridor, was expanded to reduce the number of structures, utilize lower structures, facilitate construction, and improve worker safety. PSNH has contracted to obtain additional easements and purchase new fee property in these locations. These additional land rights will allow for improved construction access and increased worker safety during construction and future maintenance, given the original narrow corridor width through this area. The location of structures outside the PanAm railway corridor will also result in fewer and shorter 115 kV structures, reducing structure visibility and overall Project cost in this area.

As a result of the added width of the ROW, PSNH was able to reduce structure heights. In the case of Madbury Road crossing, the height of the structures was reduced by over 20 feet. Moving structures further from the railroad allowed PSNH to increase the distance between structures, reducing the overall number of structures. It also allowed for the use of structures without foundations, reducing Project costs. Moving the line further from the railroad increased the distance workers would be from the active railway, reducing the risks to worker safety during construction.

Q. How did PSNH collaborate with the Town of Durham and optimize the Project design?

A. From Madbury Road to the UNH “A” lot in Durham, PSNH has contracted with UNH to obtain additional ROW width to improve and optimize the design of the new line. The original ROW could have been utilized in its original width; however, expansion of the ROW provided a number of design enhancements.

PSNH also altered its design in Durham in response to feedback provided by the Town and UNH. Representatives from PSNH, the Town of Durham and UNH met numerous times on a regular basis to discuss the Project. The downtown area of Durham was especially important to the Town and UNH and viewed by the Town and UNH as a sensitive area. As a direct result of these meetings and public input, a section of the Project will be constructed underground within the downtown area for approximately 2,100 feet. This underground section will begin north of Main Street at UNH “A” lot, travel under Main Street, and return to the overhead design south of Main Street, near the intersection of Colovos and Waterworks Roads. The underground section will be placed within existing and new utility easements, with the new easements contracted to be acquired from UNH.

The transition from overhead to underground will use specially designed transition structures at both ends. Each transition structure will be a single pole, self-supporting steel requiring a foundation. The design requires a new easement from UNH “A” lot and along the southern section near Colovos Road; PSNH has contracted to obtain these new rights. The underground cable system will be designed as a high voltage, extruded dielectric (HVED) cable utilizing cross-linked polyethylene (XLPE) insulation. Details of this underground cable are described in section 301.03 (h)(1) of the Application.

Incorporation of an underground design in this area addresses concerns raised by the Town and the University and takes into account future development plans of the Town and UNH. The underground line design is placed in parking lots, and within an existing utility corridor and along existing roadways to minimize impact to the area. PSNH collaborated with the Town and UNH on the design, to ensure it does not interfere with either the Town's or UNH's future plans.

Through collaboration with the Town, PSNH was also able to optimize its road crossing designs to further limit the visibility of the Project. PSNH undertook additional measures, including placing structures further from the road crossing and using alternative structure designs, such as H-frames at road crossings.

To facilitate construction in other areas of Durham, sections of the existing distribution lines, roadside and within the ROW will be upgraded. On Durham Point Road and Long Marsh Road, existing roadside distribution lines will be upgraded to three phase 34.5 kV. This will allow the existing 34.5 kV distribution line to be relocated and reconstructed in the ROW. The upgraded roadside distribution will remain and provide a back-up feed to the Durham Point road area, improving reliability in the section of Durham.

The Town of Durham also raised certain concerns with a section of the Project that passes through several neighborhoods east of Route 108, including, Cutts Road, Frost Drive and Sandy Brook Drive. PSNH offered to utilize two different design options through this area, namely, a design which kept the 115 kV and 34.5 kV lines on shorter but separate structures or a double circuit monopole design on slightly taller structures. The Town allowed PSNH to work directly with abutters on the structure design selection. The Town agreed to support the design selected by the majority of abutters in this area. Ultimately the majority of abutters preferred the monopole double circuit design because it reduced the amount of equipment placed within the ROW.

On the Durham side of the Little Bay crossing, PSNH initially only had an easement to construct overhead electric lines to edge of Little Bay. Using only the existing rights, PSNH would have placed the transition structure directly on the edge of the Bay. However, after working closely with the landowner that directly abuts Little Bay on the Durham side, PSNH was able to contract to acquire new land rights, which will allow for the structure to be moved approximately 360 feet from the edge of the Bay. The relocation of the transition structures will avoid and significantly minimize potential views of the Project from Little Bay and the surrounding properties and will also reduce potential environmental concerns and facilitate construction at this location.

Q. How did PSNH collaborate with the Town of Newington and optimize the Project design?

A. On the Newington side of the Little Bay crossing, PSNH initially proposed to use the existing underwater cable landing at the shoreline of Little Bay. Following this route would have required the Project to remove significant amounts of ledge, resulting in major disturbances to the shoreline and the landowner's property. PSNH successfully negotiated with the landowner on the easterly side of Little Bay to obtain additional underground rights to facilitate a shift in the location of the submarine cable landfall. This allowed for the cable to be brought on-shore with minimal impact to the shoreline and the landowner's property. After making landfall, the Project has been designed to use municipal roads, optimize the transition structure locations and utilize the existing overhead rights that remain intact.

The section of underground cable along Gundalow Landing road to the crossing of Little Bay Road will be placed within the road ROW. PSNH has investigated relocating this design to the edge of the road ROW at the request of the Town of Newington. PSNH was asked to move the design further off the road onto private property owned by residents along Gundalow Landing road. Although PSNH attempted to secure the necessary underground rights to construct the Project outside of Gundalow Landing Road, PSNH does not currently have these rights. PSNH will continue to work with the Town and affected property owners to relocate the Project onto private property in this location, provided it does not interfere with the timely processing of its Application for a Certificate of Site and Facility.

In Newington, the transition structures will be placed approximately 1,500 feet from the shoreline, limiting potential views of the Project from Little Bay. The placement of the transition structures away from the Little Bay landing is required for a number of technical reasons. Initially as designed, the underwater cable and its associated transition structures would have required that the structure be placed at the edge of Gundalow Landing Road. However, placing the transition structures at the edge of Gundalow Landing Road would have encroached on the roadway. PSNH does not have the underground rights to place the transition structures in Gundalow Landing on private property. The next available location for the structures are at Little Bay Road at the entrance to Gundalow Landing where the cable can be placed in the roadway easement and the transition pole can be placed within the existing overhead corridor.

PSNH also investigated a relocation of the transition structures at the request of the Town of Newington. The Town of Newington requested the transition structure, going from the underground cable leaving Gundalow Landing to overhead in the ROW across Little Bay Road, be relocated off the existing ROW onto Town owned property. The relocation of the transition structures will limit their visibility. However, to incorporate this design change, additional easement rights are required from the Town of Newington because the Town is the underlying land owner of this parcel. However, after continued discussions with the Town, it has not approved the grant of the required land rights to PSNH to make this structure move. PSNH will continue to work with the Town to relocate the transition structures, provided the relocation does not interfere with the timely processing of its Application for a Certificate of Site and Facility.

Also in Newington, PSNH received and considered feedback from the Town regarding the location and height of the transmission line structures in its Historic District, which resulted in the modification of the overhead structure design. First and foremost, PSNH has decided to remove the existing 34.5 kV distribution line that currently traverses the Newington Historic District and travels across the Frink Farm. The result will allow the use of fewer and shorter 115 kV structures.

Second, from Little Bay Road to approximately Fox Point Road, PSNH altered its design to use H-frame structures at the request of the Town. H-frame structures resulted in lower structure heights as compared to the initial monopole design. In this area, the change in design to H-frames resulted in an average structure height reduction from approximately 90 feet (without the distribution) to approximately 65 feet. Use of the H-frame design allows the Frink Farm to be traversed by only three structures, one at each edge of the farm property and with a single structure in the farm field. The structure in the field was placed behind existing vegetation (trees) to screen it from views from the farm house.

A portion of the ROW within Newington crosses the parking lots associated with Crossings at Fox Run Mall. In this area, Eversource optimized its structure design to limit impacts to parking and driving areas and potential disruptions to the surround businesses.

Q. How else did PSNH attempt to further avoid and minimize potential adverse effects to aesthetics and historic resources in the Newington Historic District?

A. Through continuing discussions with the Town of Newington and its residents PSNH has also offered to utilize an underground design for the section of the new 115 kV line through the Newington Center Historic District and through the adjoining neighborhood on Hannah Lane. PSNH presented this option to the Town and abutters at public meetings and separate meetings with Town officials. PSNH met several times with the underlying landowners and worked closely with the residents in the Hannah Lane residential neighborhood to discuss the underground design. PSNH presented specific design options to the owners of the Frink Farm and the Town of Newington to address certain concerns that were raised regarding the agricultural uses of the Frink Farm. PSNH offered to construct the Project underground across the farm, which in combination with the removal of the existing distribution line, would allow for the unobstructed use of the agricultural fields and return the farm scenery to its 19th century landscape and viewscape.

However, to utilize an underground design in the Newington Historic District and in the Hannah Lane residential neighborhood, PSNH requires new underground rights along the existing ROW because PSNH's existing land rights only provide for overhead construction. To date, the landowners, including the Frink Farm, have not granted PSNH the required underground rights.

Should PSNH ultimately be able to proceed with an underground design in this section of Newington, PSNH has also agreed to locate the transition structures in areas that limit visibility. These design changes can only be accomplished, however, if all residents in this area grant the necessary underground rights to PSNH and the necessary local, state, and federal approvals are granted in a timely manner.

PSNH continues to work closely with the Town of Newington and abutting landowners to secure the necessary rights to construct the Project underground in the Newington Center Historic District and Hannah Lane residential neighborhood. Should PSNH be able to obtain these rights and the necessary approvals, PSNH will submit an amendment to its Application prior to commencement of discovery in this proceeding.

Audible Noise

Q. What is audible noise (AN) and how does it relate to transmission lines?

A. There are certain electromagnetic effects associated with the overhead transmission of electrical power at high voltage which may result in an audible noise (AN). These effects are produced by the electric and magnetic fields of the transmission line, with one of the effects being corona discharge. Corona effects may manifest themselves as audible noise, radio interference, and television interference. The AN from corona may be heard as a hissing, crackling sound. The amount of noise produced by a transmission line is a function of the voltage of the line, diameter of the conductors, locations of the conductors in relation to each other, elevation of the line above sea level, condition of the conductors and hardware, and local weather conditions. These particular effects will be minimized by line location, line design, and construction practices. The AN from corona decreases with distance from the transmission line.

Q. Is audible noise a concern with 115 kV transmission lines?

A. No. Under normal equipment conditions, PSNH has not experienced AN issues with transmission lines operated at 115 kV. It is generally accepted in the utility and scientific community that corona induced audible noise typically becomes a design concern for transmission lines at 345 kV and above and is less noticeable from lines that are operated at lower voltages, such as the Project. According to P. Sarma Maruvada's "Corona Performance of High-Voltage Transmission Lines" (Research Studies Press

LTD, 2000), corona noise issues typically occur with line voltages at and above 500 kV. The proposed line from Madbury to Portsmouth will be operated at 115 kV well below this threshold level.

Q. How did you calculate the audible noise associated with the operation of the Project?

A. PSNH modeled representative sections of the proposed 115 kV transmission line using computer programs associated with the Electric Power Research Institute ("EPRI"). The EPRI "Transmission Line Reference Book, 345 kV and Above," Chapter 6, provides empirically-derived formulae for predicting audible noise from overhead transmission lines. AN is predicted for dry and wet conditions, with wet conditions representing a worst case. These procedures are considered to be reliable and represent International best practice.

Q. What audible noise levels did you calculate?

A. Computer modeling performed by PSNH indicates that under the worst case, wet conditions, scenario for operation of this transmission line at 115 kV, measured sound (dBA) measured 50 feet from centerline of the Project would not increase over the present values. Therefore, the Project is not expected to increase sound by 10 dBA or more over background levels at the edge of the right-of-way or at the edge of the property boundary for each substation and as a result should not be required to perform an assessment of operational sound associated with the Project.

Q. How do these levels compare to relevant guidelines for audible noise?

A. The AN levels in foul weather along the Project route also are well below the EPA guideline and also meet the World Health Organization ("WHO") 40 dBA guideline. The Committee has previously relied upon the 2009 WHO Guidelines, *see Antrim Wind Energy, LLC* case, SEC Docket No. 2012-01, (April 25, 2013). The Project will comply with all relevant state, federal, and international guidelines for audible noise.

Q. Please describe any radio or electrical interference that may result from the project.

A. Radio noise (RN) is the hiss or crackle you may hear on your radio while it is near a transmission line. The sound is produced by the corona activity along a transmission line. In general, modern overhead transmission lines do not interfere with normal radio reception. If interference is identified with a transmission or distribution line, then the source of interference can be located and repaired.

Loose and/or damaged hardware may also cause television or radio interference. If radio interference is caused by or from the operation of the proposed 115 kV line within a broadcast station's primary coverage area where good reception is presently obtained PSNH will inspect and repair any loose or damaged hardware in the transmission line, or take other necessary action to restore reception to the present level.

Amplitude Modulated ("AM") radio signals can be susceptible to transmission line interference. Typically AM receivers that are tuned to a weak station, below 1000 kHz, and located very near to transmission lines have the potential to be affected by radio interference. The interference decreases with greater distance from the line. Typically, 115 kV transmission lines, when operating normally, do not cause significant corona and are generally not a significant source of radio interference.

Frequency Modulated ("FM") radio is rarely affected by transmission lines; FM radio receivers usually do not pick up interference from transmission lines, Because corona generated radio frequency noise currents decrease in magnitude with increasing frequency and are quite small in the FM broadcast band (88-108 megahertz [MHz]), and the excellent interference rejection properties inherent in FM radio systems make them virtually immune to amplitude type disturbances.

Q. Are there limits for radio noise?

A. There are no state limits in New Hampshire on RN, however, the proposed line has been designed in a manner consistent with the IEEE Radio Noise Design Guide for High-Voltage Transmission Lines (IEEE, 1971). The Project will comply with these design practices to minimize RN and with the applicable Federal Communications Commission Rules and Regulations (Part 15, Section 15.25).

Q. Does this conclude your testimony?

A. Yes.