The Narragansett Electric Company

d/b/a National Grid (Interstate Reliability Project)

RIPUC Dkt. No. 4360

Testimony of

David M. Campilii, P.E.

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PREFILED TESTIMONY OF DAVID M. CAMPILII

INTRODUCTION

Q. Please state your name and business address.

A. My name is David M. Campilii. My business address is 40 Sylvan Drive, Waltham, MA 02451.

Q. By whom are you employed and in what position?

A. I am employed as a Consulting Engineer by National Grid in the Asset Management - Transmission Department.

Q. What are your responsibilities as a Consulting Engineer in the Asset Management - Transmission Department?

A. I am responsible for the design, licensing, and construction of underground transmission facilities, and I provide engineering services as requested for National Grid underground distribution facilities.

Q. Please describe your education, training and engineering background.

A. I have a Bachelor of Science degree in electrical engineering from Northeastern University, and I am a registered Professional Engineer in the State of Rhode Island. I am a member of the Institute of Electrical and Electronic Engineers (IEEE) Insulated Conductors Committee (ICC). I have been providing engineering services for underground transmission and distribution projects for approximately 28 years.

Q. Have you testified before the Public Utilities Commission or Energy Facility Siting Board in previous cases?

A. Yes, I testified before the EFSB on the Manchester Street Repowering Project, the E-183 Relocation Project, the Southern Rhode Island Transmission Project, and the Rhode Island Reliability Project. I have testified before the PUC on the E-183 Project and the Southern Rhode Island Transmission Project.

Q. Are you familiar with National Grid's Interstate Reliability Project (the "Project")?

A. Yes, I am. In addition to familiarity with the overall project, I oversaw development of an underground alternative to the proposed construction of the 345 kilovolt (kV) line (the "366 Line") between the Millbury #3 Substation (Millbury, Massachusetts) and the West Farnum Substation (North Smithfield, Rhode Island). I also oversaw development of an underground alternative to the National Grid portion of the proposed construction of the 345 kilovolt (kV) line (the "341 Line") between the West Farnum Substation and Northeast Utilities' Lake Road Substation (Killingly, Connecticut). Finally, I oversaw development of a generic one mile long underground "dip" in the proposed overhead 345 kV line construction to demonstrate the ramifications of installing a short portion of the Project underground.

Q. What is the scope of your testimony in this proceeding?

A. The purpose of my testimony is to describe the underground alternatives which were considered as part of this Project.

Q. Are you familiar with National Grid's Energy Facility Siting Board Application, including the Environmental Report ("ER") prepared by AECOM for the Project?

A. Yes, I prepared the analysis of underground alternatives in the ER.

UNDERGROUND ALTERNATIVES

Q. Please describe the underground alternatives that you examined for the Interstate Reliability Project.

A. Figure 5-11 in the ER, entitled "Interstate Reliability Project, Underground Alternative Route Map," details the Project area, shows the proposed overhead transmission route and identifies the underground alternative routes developed for the Project. Within Rhode Island, there are two 345 kV line segments associated with the Project. These include a section of the 366 Line from the RI/Mass border to the West Farnum Substation, and the 341 Line from the West Farnum Substation to the RI/CT border. Underground alternatives were developed for the entirety of each of these lines. Route selection for each alternative, as discussed in Section 5.8[1] of the ER, is summarized as follows:

Existing Overhead Right-of-Way ("ROW") Route: Use of the existing overhead ROWs for underground transmission cables was evaluated. As detailed in Sections 5.8.2.1 and 5.8.3.1 of the ER, there are significant disadvantages with using these corridors for underground transmission. The most significant issues include extensive wetlands, wetland buffer zones, water bodies along the ROW route, the existence of significant rock along the ROW, and route topography issues. While it is possible to span many of these features with the proposed overhead line construction, underground construction would require trenching or the use of other construction techniques through these areas.

[1] The ER references in my testimony are to the revised sections of Chapter 5, dated November 20, 2012. Section 5.8 was originally Section 5.7.

Initial construction and future maintenance would be difficult, and would be expected to have greater long term and short term environmental impacts than the proposed Project. The constructability and environmental issues associated with these corridors caused us to reject the use of the overhead ROW for the underground alternative on a screening level.

Public Roadway Network: As the second alternative, an underground route utilizing the public roadway network was developed. There are existing roadways that could be used to connect Millbury No. 3 Switching Station and the West Farnum Substation (the 366 Line) and the West Farnum Substation and the Lake Road Switching Station (the 341 Line).

As part of the examination of the roadway network, we examined the potential use of the Route 146 limited access corridor as an underground route for the 366 Line. Although the highway passes relatively close to the Millbury No. 3 Switching Station and the West Farnum Substation, both the Massachusetts and Rhode Island Departments of Transportation have restrictions on the use of limited access highway rights of way for longitudinal installation of utility facilities. In addition, Route 146 passes through large rock areas and there are a number of bridges on the route which have not been designed to accommodate utility lines. For these reasons, the use of the Route 146 corridor was not considered further.

Next, we developed representative underground routes for the 366 Line and the 341 Line using other state and local roads. These routes are shown on Figure 5-11. If these lines were to be constructed underground instead of overhead, we would propose to follow routes similar to those shown in Figure 5-11.

While there would be significant temporary issues during construction such as traffic maintenance, the roadway network appeared to be feasible, and did not have either the significant constructability or environmental issues associated with the existing overhead ROW corridor. The roadway network alternative was developed as the most suitable underground alternative to the Project.

Q. Please explain the underground technologies which you considered for this Project.

A. As detailed in Section 5.8.4 of the ER, we evaluated High Pressure Fluid Filled (HPFF) pipe type cables and solid dielectric cables for the underground alternative. HPFF cables consist of three laminated paper polypropylene (LPP) insulated cables installed in a steel pipe. The pipe is filled with a synthetic dielectric (insulating) fluid, which is pressurized to 200 psi. Pressurizing equipment, consisting of pumps, reservoirs, and controls are required at one or both ends of the cables.

Solid dielectric cables are insulated with an extruded “solid” material. At 345 kV, the solid dielectric insulation is cross-linked polyethylene (XLPE). This type of cable is typically installed in concrete encased PVC conduits. For the Project underground alternative, the cable technology selected was solid dielectric. Major reasons for this included:

- For a cable of the length necessary for the Project, most of the cable rating of an HPFF pipe type cable would be used in charging the cable.

- Pipe type cables would require a significant quantity of dielectric fluid, pressurized to 200 psi, resulting in operating and maintenance issues and possible environmental issues.

Q. Are there operational and maintenance issues related to underground transmission lines compared to overhead lines?

A. Yes, there are several as discussed in Section 5.8.8 of the ER.

(a) Lengthy Outage Times: One of the biggest operational issues associated with an underground transmission line is lengthy repair times. Repair times for underground 345 kV transmission lines are on the order of a month or longer. By contrast, with an overhead transmission line, failures or outages are usually corrected within 24 to 48 hours, or are only momentary in nature.

(b) Reclosing: Many faults on overhead lines are temporary in nature. It is often possible to "reclose" (re-energize) an overhead line, resulting in only a momentary outage. Faults on underground lines are almost never temporary in nature, so reclosing is typically not performed for underground lines.

(c) Line Ratings: It can be difficult to match the power rating of an overhead line with underground cables. Future capacity upgrades are typically more difficult with underground cables than overhead lines if that became necessary.

(d) Cable Capacitance: Underground cables have significantly higher capacitance than overhead lines. As a result, part of the cable's capacity is used by the charging current so larger conductors are required to transmit an equivalent amount of power. Cable capacitance can lead to voltage control issues at light load, and can require installation of additional equipment to compensate for the line charging. Addition of shunt reactors at the West Farnum Substation and Millbury No. 3 and Lake Road Switching Stations would be necessary to offset the cable capacitance.

(e) Cable Reactance: Cables have lower series reactance than overhead lines. If an underground cable is put in parallel with an overhead line, the cable will tend to "hog" the load, resulting in possible power flow control issues. This could trigger the need for additional transmission equipment to better balance line flows.

These operational issues collectively make it more difficult and costly to incorporate underground transmission cables into the grid.

Q. What is the estimated cost of the underground alternative?

A. The cost estimate for an underground alternative to the 366 Line and the 341 Line is $1.26 billion, compared to an estimated cost of $214 million for the comparable overhead transmission lines. Estimates of the costs of the various components were developed using a combination of historic project costs from similar projects, estimating quotations from manufacturers and installers, and visual and "literature search" assessment of route features. The costs presented are study grade estimates which are expected to have an accuracy of +/-25% and are based on a conceptual design of a project.

The details of these estimates are contained in Table 5-16 of the ER. There are a number of costs in the Project cost estimate contained in Table 4-3 that are common to an overhead or underground alignment (e.g., the reconstruction of the Sherman Road Switching Station) which are not included in Table 5-16. On the other hand, Table 5-16 includes the cost of the entire 366 Line from the Millbury No. 3 Switching Station to the

West Farnum Substation and the cost of the entire 341 Line from the West Farnum Substation to the Lake Road Switching Station, while the Table 4-3 estimates are only for the Rhode Island components of the Project.

Q. What is the most practical underground alternative?

A. Any underground alternative would be expected to have significant cost, operational, and schedule disadvantages compared to the proposed Project. At this point, we believe the most practical underground alternative would be one that would use the roadway network, and which would utilize solid dielectric cable construction.

Q. You have discussed a number of disadvantages of underground transmission. When would National Grid consider installing underground transmission lines?

A. In general, National Grid proposes overhead transmission lines as the preferred technology for most additions to the transmission system. This is primarily for reasons of cost, and for the reliability and operational issues discussed in the ER and in this testimony. However, there are occasions when National Grid may propose or accept underground transmission as the technology for a particular project. The most common situation where National Grid would propose underground transmission is where National Grid had no overhead ROW and no practical means to obtain a ROW (due to cost, availability, timing, or other reasons). The E105 and F106 cables between Manchester Street Substation and Hartford Avenue Substation are an example of this, where it would have been impractical to create a 250 foot wide ROW corridor for overhead lines from downtown Providence to the I-295 - Route 6 area of Johnston.

Another situation where National Grid would consider underground transmission would be a situation where an overhead transmission line would affect the operation of an airport. In this case, a short "dip" in the overhead transmission line would be installed, with an overhead to underground transition station at each end of the underground transmission line.

National Grid will also consider underground transmission lines at or near existing substations when it is determined that there is not adequate space around or within an existing substation for a proposed expansion. This type of installation will typically take the form of a short underground "getaway" with a transition to an overhead transmission line outside the substation.

In cases of long water body crossings, where it is impractical to span the water body from shore line towers, National Grid will consider submarine cables (a form of underground transmission line) for the water crossing.

Finally, under some circumstances, National Grid will consider installing an underground transmission line when a customer requests underground supply and pays for the cost of the underground line. For this type of request, National Grid would need to evaluate the effect on the larger transmission system before agreeing to an underground installation.

In each of these circumstances, National Grid evaluates the particular issues associated with underground transmission lines (line ratings, longer outage restoration times, different electrical characteristics from overhead lines, etc.) Addressing these issues often results in installing more than one underground transmission cable in situations where a single overhead transmission line would have been adequate. Compensating for underground transmission issues also typically involves installing more equipment at the terminal substations, and sometimes imposing operating restrictions on the system.

Q. You referred to a "dip" in the answer to the previous question. Would National Grid consider putting a dip in an overhead transmission line for reasons other than to avoid interfering with airport operations?

A. We are occasionally asked to put an underground dip in an overhead transmission line as it passes a particular neighborhood. We have included a discussion of the cost and implications of constructing a short underground segment in an overhead transmission line in Section 5.8.10 of the ER. In addition to the significant cost and operational issues that would result, it would be necessary to build transition stations, each occupying approximately 2.5 acres, at each end of the dip. Because of the operational complications and cost, unless there is a very strong justification, we would not install a dip in an overhead transmission line.

Q. Does this conclude your testimony?

A. Yes, it does.