STATE OF CONNECTICUT

SITING COUNCIL

Re:	The Connecticut Light and Power Company and The United Illuminating Company Application for a Certificate of Environmental Compatibility and Public Need for the Construction of a New 345-kV Electric Transmission Line and Associated Facilities Between Scovill Rock Switching Station in Middletown and Norwalk Substation in Norwalk, Connecticut Including the Reconstruction of Portions of Existing 115-kV and 345-kV Electric Transmission Lines, the Construction of the Beseck Switching Station in Wallingford, East Devon Substation in Milford, and Singer Substation in Bridgeport, Modifications at Scovill Rock Switching Station and Norwalk Substation and the Reconfiguration of Certain Interconnections	)	Docket 272 July 19, 2004

DIRECT TESTIMONY OF ROGER ZAKLUKIEWICZ REGARDING THE POTENTIAL USE OF HVDC

Q. Would you please identify yourself and the other member of the panel who will respond to cross examination regarding the potential use of high voltage direct current ("HVDC") for a portion of the Middletown to Norwalk Project (the "Project")?

A. I am Roger Zaklukiewicz, Vice President, Transmission Projects, of Northeast Utilities Service Company ("NUSCO"). I am presenting this testimony on behalf of The Connecticut Light and Power Company ("CL&P") and The United Illuminating Company ("UI") (together, I refer to CL&P and UI in this testimony as "the Companies"). Mr. Reigh Walling of GE Power Systems Energy Consulting ("GE"), who has previously testified before the Connecticut Siting Council ("Council") in this docket, will be on the witness panel with me in the July hearings. Mr. Walling's resume has

previously been submitted to the Council. Mr. Walling is an internationally known expert on HVDC who is employed by GE and is familiar with the Project and the Connecticut electric system from his earlier work on harmonics and resonances. As the Council will recall, Mr. Walling testified at the June hearings.

Q. What is the purpose of your testimony?

A. The purpose of this testimony is to discuss the Companies' further consideration of HVDC as part of the Project.

Q. Did the Companies initially consider HVDC for use in the Project?

A. Yes. The choice of transmission technology is discussed in my April 8, 2004 pre-filed testimony at pages 19-23, my March 9 pre-filed testimony at pages 36-37, and in Section G.4.3 of Volume 1 of the Companies' October 9, 2003 Application. As stated on page G-14 of Volume 1, the Companies initially rejected an HVDC component because the operational complexities of an HVDC line rendered the technology technically inferior to an AC solution. Moreover, as discussed in my April 8, 2004 testimony, there are a number of significant disadvantages to HVDC that render it less desirable than an AC solution for meeting the reliability needs of Southwest Connecticut that the Project is designed to address. HVDC would also be significantly more expensive than AC, and land would need to be acquired for the converter stations necessary to convert HVDC to AC, and vice versa, at each connection of the HVDC line to the AC system.

Q. Public Act 04-246 was enacted after the Application was filed. In light of the emphasis of this legislation on the installation of 345-kV transmission lines underground, as well as questions from Council members about HVDC, did the Companies renew their consideration of HVDC?

A. Yes. The Companies' previous consideration of the potential use of HVDC technology was based upon work by Black & Veatch and by the Companies themselves. After the June hearings, the Companies asked GE to undertake a preliminary evaluation of the technical feasibility of HVDC alternatives for the portion of the Project from Beseck to East Devon, in light of the body of knowledge that GE has accumulated with respect to Connecticut's transmission system in the course of performing and in light of Mr. Walling's HVDC expertise.

Q. Have Mr. Walling and GE completed this preliminary evaluation of HVDC?

A. Yes. I have attached to my testimony the Report dated July 2004, entitled "Preliminary Evaluation of the System Compatibility of an HVDC Transmission Alternative for the Beseck-East Devon Segment of the Middletown – Norwalk Transmission Project" ("Report"). The initial Report has a "particular focus on the impact of this alternative on ac system resonances which have been previously identified as an issue for the Middletown – Norwalk transmission project." (Report, p. 2)

Q. Based on the Report, do the Companies believe that HVDC is technically feasible for the portion of the route between Beseck and East Devon?

A. The Report concludes that "HVDC options do not appear to be a technically viable alternate for providing a 1200 MW transmission path from Beseck to East Devon."

Q. Is electric system resonance a major reason that the Report concludes that HVDC is not technically feasible?

A. Yes. The electric system resonance impacts set forth in the Report for both conventional HVDC and voltage source converter HVDC ("VSC-HVDC") are significant, leading to system resonances at extremely low multiples of the normal frequency.

Table 2 of the Report indicates that with conventional HVDC between Beseck and East Devon, the first resonant frequencies at the East Devon Bus would be between 1.5 and 2.1 times 60 Hz, both well below the 3.0 number that ISO-New England has stated generally should be the minimum first resonant frequency for the system.

For VSC-HVDC (sometimes referred to colloquially as "DC Light"), the first resonant frequencies would be between 1.4 and 2.0, as shown on Table 3 (p. 12) of the Report, again well below 3.0.

Q. Why would the system operate at such a low first resonance frequency if HVDC is used?

A. Neither a conventional HVDC system nor a VSC-HVDC facility by itself strengthens the electric grid in Southwest Connecticut (i.e., adds short circuit strength to the bulk power system). In addition, unlike an AC transmission line, neither conventional HVDC nor VSC-HVDC technology allows the short circuit strength at one

location on the AC system to be transferred to another part of the bulk power system. As the Report states (at p. 2), "replacing the proposed 345 kV ac transmission link between Beseck and East Devon with an HVDC system severs the remaining portion of the ac loop from its strongest source of short-circuit strength."

Q. Can this harmonics problem be resolved?

A. I cannot answer that definitively at this time. The Companies are talking to ABB Group ("ABB"), the major supplier of VSC-HVDC, regarding whether there is a means of addressing this issue. While it is clear that the configuration studied – DC underground from Beseck to East Devon, and AC underground from East Devon to Norwalk – does not work from the standpoint of harmonics, it is not clear whether sufficient capacitance can be removed without having to reduce further the number of miles of 345-kV underground cable that can be employed or determining whether there are other technologies that can be employed that meet the design and operating requirements identified in Section G of Volume 1 of the Application.

Q. How will these discussions with ABB be pursued?

A. The Companies have asked ABB to consider the harmonics problem as well as other potential operational challenges associated with VCS-HVDC. The Reliability and Operability Committee, which was formed after the June hearings, has the express purpose of determining how to achieve the maximum amount of underground on the Middletown to Norwalk Project, consistent with reliability needs of the electric system, and is therefore the appropriate forum for pursuing these discussions. The Reliability and

Operability Committee, comprised of technical personnel from ISO-New England and the Companies, has added consideration of VCS-HVDC to its planned work.

Q. Is harmonics (system resonance frequency) the only significant concern regarding the use of HVDC?

A. No. If sufficient capacitance can be removed from the system so that the system resonant frequency is 3 times 60 Hz or greater with VSC-HVDC, then other studies will need to be undertaken. The Report identifies voltage stability and transient stability as issues that would need to be addressed. It should be noted that the Reliability and Operability Committee has previously identified that a number of studies, including harmonics, transient, thermal and voltage, stability and short circuit, could be necessary for any "case" considered by the committee. These types of studies are listed in the Study Cases document attached to the agenda for the first weekly teleconference (July 5, 2004) on the status of the studies of the Reliability and Operability Committee.

In addition, the power flow response of HVDC is limited compared to an AC system. Using an HVDC line increases the contingency load on AC lines in the area, as discussed at pages 6-7 of the Report. Multiple parallel converter stations at each end of the HVDC line would also be required. Finally, as stated in the Report, the line losses for VSC-HVDC are far greater than for either an AC system or a conventional HVDC line. With a transfer of 1,200 MW between Beseck and East Devon, the report estimates the incremental line losses at 64 MW for VSC-HVDC compared to AC.

HVDC does not resolve existing system constraints such as short circuit currents or the conditional dependency of generation at Bridgeport and Devon. Other solutions

would be necessary for these matters, which may require new transmission lines. Further, as discussed in my April 8, 2004 pre-filed testimony, HVDC greatly complicates and constrains expansion to meet future system needs. Power rating of an HVDC system cannot be easily expanded, and accordingly should be oversized upon its initial installation to allow for future load growth. In addition, the ability to tap an HVDC line to add a substation to serve future load growth or to interconnect a generating unit would need to be addressed.

We also need further information regarding overload capability of HVDC. As the Council is aware, an AC facility has a short-time and a long-time overload capability. It is my understanding that unlike AC, a conventional HVDC converter terminal facility has very limited overload capability. ABB would need to verify whether any overload capability exists with its HVDC Light converter facility.

Q. Does this complete your testimony?

A. Yes, this completes my pre-filed testimony on HVDC as of the information known to date. I will be available throughout the July hearings, and Mr. Walling will be available to respond to questions regarding HVDC and to provide any updated information gained from the Reliability and Operability Committee's continued work on this subject.