March 19, 2004

Ms. Pamela B. Katz
Chairman
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: Docket No. 272 - Middletown-Norwalk 345kV Transmission Line

Dear Ms. Katz:

This letter provides the response to requests for the information listed below.

While it is not possible to provide all the information requested at this time, the Company is attaching the information which has been completed.

Response to CSC-01 Interrogatories dated 03/03/2004
CSC - 011 , 013 , 028

Very truly yours,

Anne B. Bartosewicz
Project Director - Transmission Business

ABB/tms
cc: Service List

Witness: Dr. Bailey
Request from: Connecticut Siting Council

Question:
Provide tables for the existing and proposed electric and magnetic fields of the figures represented on pages 30 through 80 in Volume Six of the application. Identify the assumed loads in amperes.

Response:
Please see the response to TOWNS-02, Q-TOWNS-036, part a.

Witness: **Roger C. Zaklukiewicz**
Request from: **Connecticut Siting Council**

Question:
Provide substation equipment specifications for noise emissions identifying incremental decibel ratings versus distance.

Response:
Transformers would be specified to no greater than 65 dBA (average A-weighted sound levels, measured in dB at a distance of 1 foot from the surface). Shunt reactors would be specified to 70 dBA (measured in the same way). The emergency generator at the East Devon Substation is specified to no greater than 75 dBA (measured at a distance of 50 feet from the generator in any direction). Please refer to Volume 4 of the Application entitled "Facility Sound Analysis" (specifications set forth on page 3 of the East Devon Report and on page 4 for the Singer and Norwalk reports).

All of the sites will contain 345-kV circuit breakers. These breakers will be located in Gas Insulated Substation buildings at Singer and Norwalk substations and located in the station yards at Scovill and Beseck switching stations and the East Devon Substation. These circuit breakers do not produce noise during normal system operation, however, they do produce an impulse noise when tripped. The Companies would specify that circuit breakers are not to exceed 100 dB while opening or closing.

Witness: Roger C. Zaklukiewicz; Peter T. Brandien
Request from: Connecticut Siting Council

Question:
Provide an all underground proposal and identify parameters that would be required for such a proposal.

Response:

The parameters to determine an underground proposal (identified in Section H.1.1 of Volume 1 of the Application) are system benefits (operability /reliability), environmental impacts, engineering (technical) feasibility, potential property impacts, and cost. As part of the process of designing the Project, the Companies first sought to identify a physically practical underground route for each segment of the Project. This process is described in Section H.1.3 of Volume 1 of the Application. However, the Companies have determined that no all underground route satisfies these parameters, and therefore the Companies cannot provide an all underground "proposal" in response to this interrogatory just as they did not propose an all underground option in the Application. This response explains the technical reasons that have caused the Companies to conclude that they cannot propose an all underground line. At the same time, to respond to the Council's request as fully as possible, this response identifies the route that would probably be specified from a routing perspective if an all-underground or near all-underground route were otherwise able to meet the evaluation parameters.

Essential Project Purpose
The Project was designed to incorporate the resources that are located in the Middletown area and to reliably bring this power into SWCT while improving the east to west transfer capability without adversely impacting the reliability of the existing bulk power system. The Beseck Switching Station will form an electrical “hub” in the Middletown area. It will be a vital link and central artery for power to flow across Connecticut and the region. The Project significantly increases the capability of the bulk power system to move power from east to west by bringing a new 345-kV transmission line directly into the SWCT area. The reliability of the line segments serving Beseck and of the long line from Beseck to East Devon is critical to achieving this purpose.

The loss of any of these lines would restrict east to west transfers and the loss of one of them (the Millstone line) could constrain Millstone generation. Accordingly, it will be critical to maintain these lines in service, and to be able to quickly restore them to service in the event of a fault, whatever the initiating reason. Underground segments on these lines are not recommended because, in contrast to overhead lines, faults on underground cables are permanent in nature; universally, prudent utility practices do not allow reclosing of a high voltage underground cable after a fault occurs. Faults on underground cables can require weeks to locate and months to repair. Therefore, in order to provide transfer capacity and continuity of service approaching that of overhead lines, these segments would require significant redundancy; mutiple cables would be required. As discussed in the following section, each additional segment of underground cable increases the capacitance of the system and adds to system reliability and operability problems.

A Nearly All Underground Route

The various potential underground segments that the Companies identified are shown as underground “Links” on the two large maps contained in the plastic pocket in the back of Volume 1 of the Application, entitled: "Route Analysis Map - Middletown - Norwalk 345-kV Transmission Line, DWG No. RA - 001 Sheet 1 of 2 and Sheet 2 of 2". Strictly from a routing and construction perspective, the Companies have identified a nearly all underground route. This route would consist of: (a) the proposed underground route between East Devon and Norwalk; and (b) an underground route for Segment 1 (from Oxbow Junction to Beseck and from Black Pond Junction to Beseck) and Segment 2 (Beseck to East Devon) consisting of the following "Links" shown on Sheet 1 of 2 of the Route Analysis Maps: Link Numbers: 2a, 2u, 3a, 3u and 3v for Segment 1 and 3v, 5u, 6, 11, 14, 16 and 20 for Segment 2. No underground link is shown for the segment between Chestnut Junction and Scovill Rock because there are no streets that would serve this purpose and the overland terrain is not suitable.

Please note that the Route Analysis Map shows only the location of the underground lines, and not the location of any additional substations or switching stations that would be required. If the Companies were to design a nearly all underground line, the design would specify at least one, and possibly two or three switching stations along the route between Beseck and East Devon, in order to mitigate the reliability issues associated with what would otherwise be an approximately 30.4 mile long 345-kV underground cable (a total of 91 circuit miles).

Including the approximately 9.1 mile segment between Oxbow Junction and Beseck and the approximately 4.0 mile segment of two 345-kV lines between Black Pond Junction and Beseck, the route from Beseck to East Devon would add approximately 30.4 miles for a total of approximately 47.5 miles of underground 345-kV HPFF cables (a total of 159.6 circuit miles) to the Connecticut transmission system. This would add to the Connecticut system, over and above the approximately 71 circuit miles of 345-kV cable associated with (a) the 23.6 circuit miles approved as part of the Bethel to Norwalk line; (b) the 16.2 circuit miles proposed for the segment between East Devon and Singer; and (c) the 31 circuit miles proposed for the segment between Singer and Norwalk. The following table summarizes the cable configurations and distances between termination points. As discussed below in this response, these underground additions would raise significant reliability concerns.

To	From	Distance	Number of Cables	Circuit Miles	Type
Bethel	Norwalk	9.7	2	19.4	HPFF
Bethel	Norwalk	2.1	2	4.2	XLPE
Oxbow	Beseck	9.1	4	36.4	HPFF
Black Pond	Beseck	4.0	8	32.0	HPFF
Beseck	East Devon	30.4	3	91.2	HPFF
East Devon	Singer	8.1	2	16.2	HPFF
Singer	Norwalk	15.5	2	31	HPFF
	Total =	78.9	Total =	230.4	

By comparison, Con Edison of New York has approximately 165 circuit miles of underground 345-kV transmission lines and NSTAR in Boston has approximately 35 circuit miles.

Cable Reliability:
In Docket 217, international cable expert Brian Gregory estimated, based on historical experience, that the fault rate of 345-kV HPFF underground cables (the most reliable underground technology in the United States) would be one per hundred miles every two years per three cable circuit. Two circuits are specified for the underground segments of the proposed Project; between East Devon and Singer Substations and Singer and Norwalk Substations. There would be three circuits specified for any underground line between East Devon and Beseck Substations, four circuits between Beseck Substation and Oxbow Junction, and four circuits between Beseck Substation and Black Pond Junction. Two circuits will be installed in both the 345-kV HPFF and XLPE underground segments of the Bethel to Norwalk Project. Thus, if all underground construction were ordered for the Oxbow Junction to Beseck, Black Pond Junction to Beseck and Beseck to Norwalk segments, there would be a total of approximately 230 circuit miles of 345-kV HPFF cable in the Connecticut transmission system. Based on Mr. Gregory's testimony the Companies would expect to experience more than one 345-kV cable fault per year. Faults on an underground system typically require weeks to locate and could require months to repair; and during this period, the entire circuit on which the fault occurs is unavailable, increasing the system's exposure to additional unacceptable levels of risk.

Operational Reliability Issues

Cable Capacitance
As discussed in section H.1.3 on pages H-8 and H-9 of Volume 1 of the Application, capacitance, which is typically not a problem with overhead lines, can become a critical issue as the installed amount of high voltage underground cable increases. Capacitance creates issues with respect to switching transients, voltage control and swings, transfer limit limitations and stability. Underground cables, particularly 345-kV HPFF cables, have significantly more capacitance than overhead lines. Most electric utilities in the United States are able to effectively manage the capacitance of overhead lines with switched devices and do not have to compensate for the overhead lines' capacitance. These operability and reliability limitations must be considered in evaluating the amount of underground cable that can be added to the Connecticut system in this Project. The significance of these operability limitations is especially critical in Connecticut because the level of capacitance existing on Connecticut's transmission system is already significantly higher than it has been in the past, and higher than that of other electric utilities in the region. The additional capacitance associated with the underground segments of the Bethel to Norwalk project and the proposed underground segments of this Project will make the installed and switched capacitance of Connecticut's system more atypical and problematic. Undergrounding the line segments between Oxbow Junction and Beseck Substation, Black Pond Junction and Beseck Substation and East Devon and Beseck substations would significantly increase the system capacitance. Contingencies or the slightest operator error could result in system collapse, equipment damage, or both. Repair or replacement could take months and could cost tens or hundreds of millions of dollars. During the repair period, Connecticut's customers would be at severe risk of experiencing further transmission outages.

The CT Transmission System: *High Capacitance in a Relatively Weak System*
Adding capacitance to Connecticut's transmission system is particularly problematic because it is already a high capacitance system, even though it is almost all overhead. The reasons for this atypical characteristic are historical. Historically, generation plants were sited next to large "heat sinks" (rivers, for example) needed to serve as a cooling source for these plants. In southwestern Connecticut, generating stations were located in Milford, Bridgeport, New Haven and Norwalk, near high density load centers. The capabilities of the local transmission system matched the capacity of the generating stations. In central and eastern Connecticut, large central generating stations were located in the Waterford, Montville and Middletown areas. These generating stations were large and required interconnection into the 345-kV transmission system. In addition, numerous small cogeneration plants were constructed throughout Connecticut. With this generation available and on-line, Connecticut had an abundant supply of electric power compared to load demand and typically exported power to neighboring utilities on most days.

In the 1990's the power flow out of Connecticut reversed, placing additional strains on the Connecticut transmission system. Connecticut became a net importer, rather than an exporter, of electricity for three primary reasons. First, several older, more operationally expensive fossil plants such as Middletown #1, Devon #3, 4, 5, and 6, Bridgeport Harbor #1, and English Station were retired or mothballed. Second, new power resources were operating outside of Connecticut, including large central generating stations such as Seabrook Station commencing commercial operations. Third, the Hydro Quebec Phase 2 HVDC tie with Canada went into operation. In 1996, significant generation shortages in Connecticut were experienced when approximately 3,200 MW of baseload generation was not operating (Connecticut Yankee and all three Millstone units). At the same time, Connecticut's peak load was growing and reached approximately 5600 MW.

The net effect of generation retirements, generation shutdowns and load growth resulted in power imports that caused higher losses and greater voltage drops on the transmission system. The lost generation had two important effects: the loss of real power and capacity and the loss of reactive output from those generators. The dynamic reactive capabilities from these units had provided fast-acting, automatic response to maintain system voltages and stability under normal and contingency conditions.

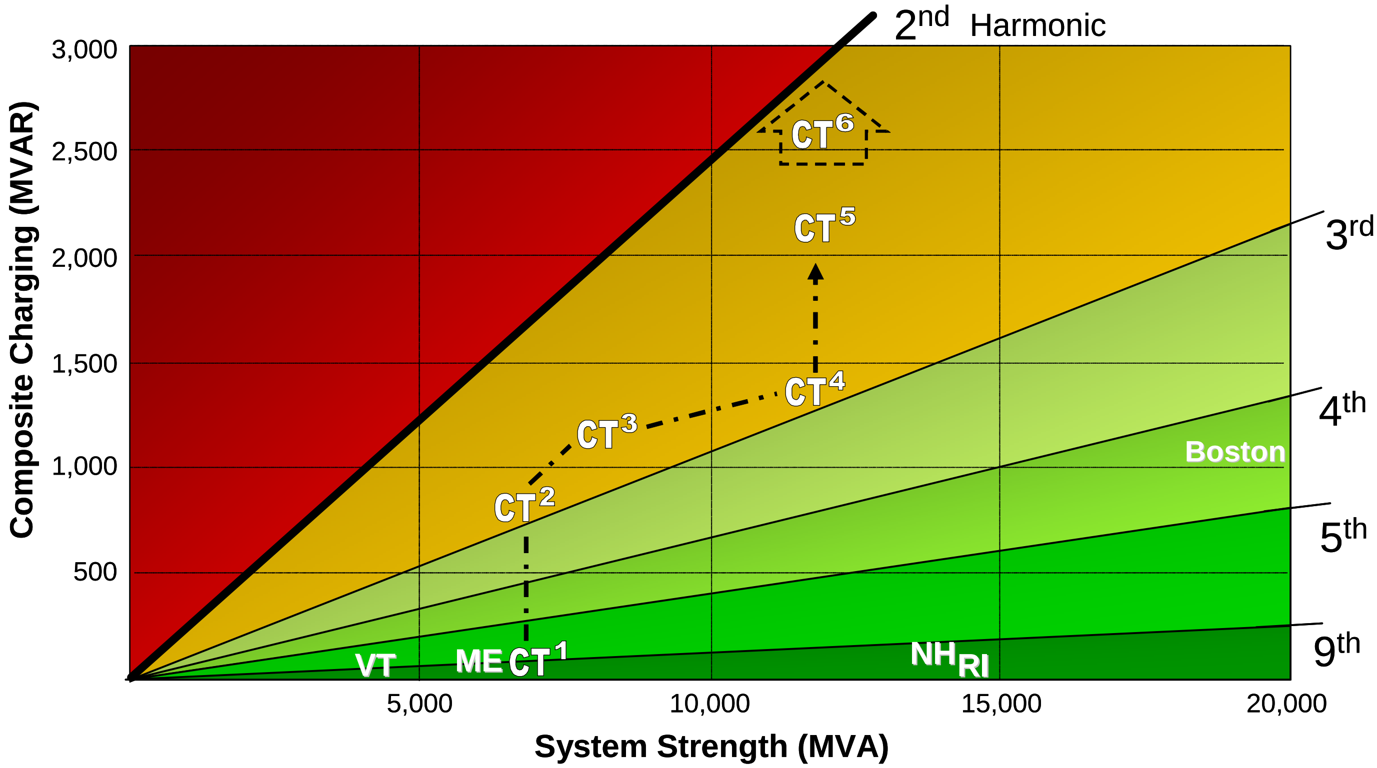
This was a dramatic change to the operation of Connecticut's bulk power system, which in previous years had focused on the export of power. Now Connecticut had to immediately address the issues associated with being a net importer of power. The Companies were challenged to maximize the power imports into Connecticut in the event that in-state generating units tripped off-line during high load demand periods. The studies showed that the principal limitation on Connecticut import limits was voltage rather than thermal constraints. To address these voltage limitations and thereby increase the Connecticut import limits, the Companies installed a significant number of fixed shunt capacitors at substations throughout the state. These capacitors compensated for the loss of reactive output from the generators and the voltage drop associated with the import of power from generating plants appreciably further from Connecticut's load centers. The loss of the larger generation units in SWCT caused a drop in the Connecticut import limits. The reactive output and local distribution of electric power from units within SWCT supported the voltage profile in the area and had a wider impact throughout Connecticut. Importing power from remote generating stations creates higher system losses, which suppresses system voltages. The Companies installed additional capacitors in SWCT to "prop up" the SWCT transfer limits to maintain the Connecticut import limits. As a result, Connecticut has over 2,000 MVAR of shunt transmission capacitors. A typical transmission system of comparable size would have less than 1,000 MVAR. Consequently, even before the added capacitance associated with the underground cables to be installed on the Bethel to Norwalk Project and the Middletown to Norwalk Project, the Connecticut transmission system has a far greater amount of capacitance relative to the strength of the bulk power system than all other power systems in the region. High capacitance in a relatively weak system is of great concern because of its effect on harmonics.

Harmonic Effects

Sixty cycles per second (Hz) is the normal operating frequency for electricity in the United States. The 60 cycle frequency is known as the "fundamental frequency". Power system harmonics are multiples of the fundamental frequency. For example, the second harmonic has a frequency of 120 Hz and the third harmonic has a frequency of 180 Hz. Customer equipment, particularly computers and other non-linear loads, inject harmonic frequencies onto the power system. Such "dirty power" typically has a large component of the lower order (e.g., second to fifth) harmonics. Typically, power systems have resonances above the fifth harmonic, so that they have a low risk of amplifying these lower harmonic frequencies. When such amplification does occur, the system and customer equipment become more vulnerable to equipment damage and misoperation. Thus, system designers seek to avoid resonance at lower order harmonic frequencies.

The attached diagram provides a comparison of the relative capacitance and system strength of the Connecticut transmission system (both before and after the Middletown to Norwalk Project) with other electric systems in the region:

Harmonic Comparison of the Transmission System in New England



The system in Connecticut is moving toward the second harmonic with increased system reliability risks.

CT¹ – Connecticut (CT) Today with capacitors off

CT² -- CT Today, with capacitors on to accommodate the generation situation

CT³ – CT with the Bethel-Norwalk Project as approved, with capacitors on

CT⁴ – CT with the Bethel-Norwalk Project as approved and the Middletown-Norwalk segment as all overhead, with capacitors on

CT⁵ – CT with the Bethel-Norwalk Project as approved and the Middletown-Norwalk Project as proposed (24 miles of underground), with capacitors on

CT⁶– The direction the CT system moves as more 345-kV underground is added

As the diagram shows, with the Companies' proposed undergrounding, the Connecticut transmission system will be much closer to the second harmonic, and significantly different from neighboring systems.

The Companies retained GE Power Systems to perform a transient network and harmonic analysis of the nearly all underground configuration. In November of 2003, GE advised that such a configuration "is potentially very risky and is not recommended." *See,* the Companies' Supplemental Filing, December 16, 2003, Attachment C, at p. E-1.